McGRAW-HILL
PUBLISHING COMPANY, INC.
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POWER

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Volume 67 New York, April 10, 1928 *Number* 15

Hail, N. A. P. E.!

THE National Association of Stationary Engineers, after an existence of nearly half a century under that title, has decided, by referendum vote, to change its name to the

NATIONAL ASSOCIATION OF POWER ENGINEERS

Years ago, when the steam engine was, aside from water, the only material source of power, a National Convention voted to change the name to National Association of Steam Engineers, but reconsidered its action before adjourning.

Notwithstanding the encroachment of the electric locomotive and the internal-combustion engine, the Locomotive Engineer and the Marine Engineer are distinctive classes, with definite duties and qualifications.

There has, however, come about a material change in the status and functions of the stationary engineer.

This class is not defined by license requirements except in a few states. Neither a government license nor a union card is necessary to work at it. Its principal organization, that under review, comprises not over ten per cent of the United States Census enumeration of the class.

This organization consists principally of executive engineers or of those who are seeking to qualify for and fill such positions; but it includes men of every degree of training, ability, responsibility and standing, from the manual worker who attends upon the routine requirements of certain machines, to the professional engineer in charge of the power plants of a great corporation or of the stations of a public utility.

The term Stationary Engineer had come to signify to the popular mind the man who drives a stationary engine as the Locomotive Engineer drives a locomotive or a watch engineer drives a marine engine.

The Power Engineer means something more than this. There are coming to be more and more Power Engineers; not men who run engines, but men who run power plants.

The new title identifies the Association with this class without excluding the operative element and opens it to all those who have to do with the production and distribution of power to whatever purposes it may be applied.

F. R. Low

New Power and Process Hookup at Tennessee Paper Company

By L. H. MORRISON
Editorial Staff, "Power"

By installing generating units and using the exhaust steam, increased economies were obtained. All live steam to the paper machines was discontinued. Pulverized coal reduces the coal and labor charges

MORE power is needed in many paper mills than is required to supply exhaust steam for the processes as a mill is usually laid out. In addition there is a current belief that live steam increases the output of the driers. These arguments frequently have led to the combination of steam engine and purchased power or to steam engines and Deisel units.

The Tennessee Paper Company has improved upon both of these plans and by an intelligent arrangement of non-condensing and condensing engines has been able to eliminate all live steam to the heaters and to discontinue the use of purchased power. So successful has the operation been that the coal bill now is no greater than when the major part of this Chattanooga, Tenn., mill was operated with purchased energy.

Originally, this mill had two 3,600-sq.ft. Heine water-tube boilers which were hand fired. To handle the rolls a duplex 16x18-in. Brownell slide-valve engine with a variable-speed governor was used. The exhaust was sent to the feed-water heater and to the drying rolls at 35 lb. back pressure.

The beaters, jordans, etc., were driven by individual motors, totaling about 500 hp., using outside energy.

The hook-up of the power plant and the paper machinery is shown in Fig. 3 diagrammatically.

Water was pumped from the Tennessee River by a 900-g.p.m. two-stage centrifugal pump. This water was used for the boiler feed, although the connection is not shown in the drawing. Most of the water, however, went to the wet end of the paper machine, where it was used in cooling the felt. It picked up some of the paper stock and dropped into a sump at a temperature of 100 deg. F. Part of this dirty water was passed to the beaters, where it was mixed with the ground material. These beaters were heated by live steam at 175 lb. gage, coming from the boilers, the steam going into the mixture in the beaters through open-ended pipes. The stock was heated during the beating process to 170 deg. F. and then passed to the wet end of the paper machine. The exhaust from the duplex steam engine passed to the drying rolls of the paper machine and to the feed-water heater, as shown. As the heater was of the open type, a reducing valve was placed in the exhaust-steam line.

How much heat had to be applied to the beaters may be estimated from the paper output, which was about 50 tons every 24 hours; for every ton of paper about two tons of water was added in the beaters, and all this material had to be heated to 170 deg. F.

Hand firing of the boilers required that the coal be high-grade. This was no obstacle until miners' wages and freight rates advanced so much that such coal could not be procured under $5 per ton. This led to the installation of two Erie City coal pulverizers. The original furnaces were too small for pulverized coal burning, and a Dutch oven extension was built in front of the existing furnaces. This equipment permitted a cheap grade of slack and run-of-mine coal to be burned successfully. The rate of evaporation was improved, but the greater saving was obtained through the use of cheap grades of coal.

In 1926 studies of the problem of cheaper power led the management to install two cross-compound condensing, Watts-Campbell Corliss engines driving generators.

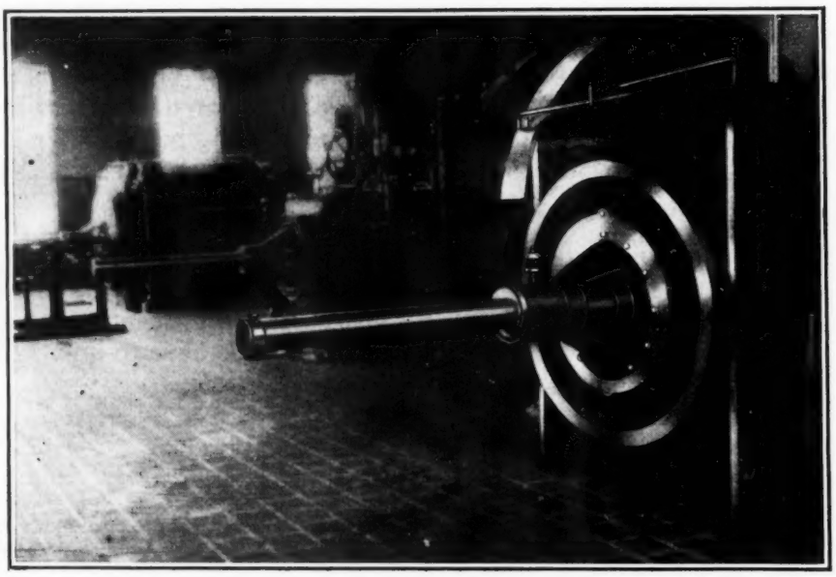


Fig. 1—Two compound Corliss engines were installed

Since more steam would be needed for the generating units, a 5,800-sq.ft. Walsh & Weidner inclined-tube boiler was installed along with two more pulverizers. It was felt that load changes could be better handled by two small pulverizers than by a single large one.

Later, in 1927, a 22x36-in. Allis-Chalmers Corliss was

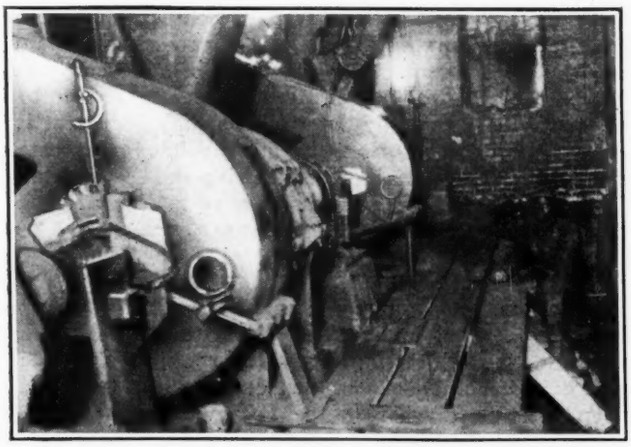


Fig. 2—Unit pulverizers are placed in front of the boilers

installed to run the beaters and the continuous rolls and outside power discontinued.

The way the power and processes are hooked up at present is shown in Fig. 4. The dirty water from the wet end of the paper machine drops, as before, into a sump *A*, from which it is drawn by the jet condenser *B*, of one of the 637-kva. cross-compound engines. The condenser pump delivers the cooling water and con-

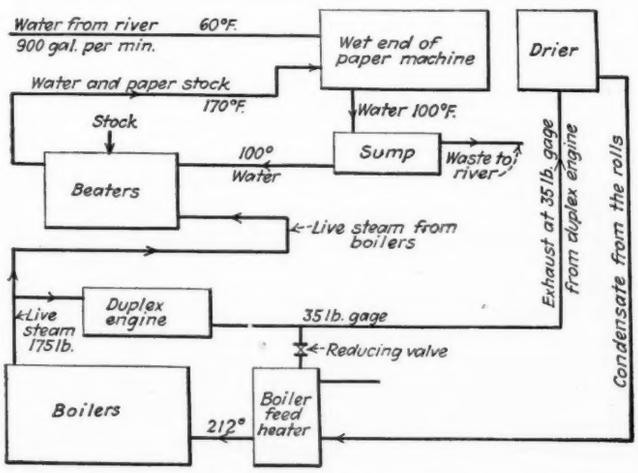


Fig. 3—Original layout of steam and water

densate mixture to a sump *C*, out of which it is raised by a small pump and forced through the heater *D*. This is a closed heater, and the water is heated to 170 deg. F. by exhaust steam coming from the duplex and the Corliss engine, *G* and *H*, at 35 lb. gage. The water flows by gravity into the beaters *E*. It will be noticed that live steam no longer goes to the beaters. The water needed by the beaters at times is less than passes through the condenser, so part of the water flows from *C* back to sump *A* and passes through the condenser a second time. This raises the condensing water temperature from 100 to as high as 140 deg. F. Part of the exhaust from *G* and *H* passes to the rolls *J* and to the feed-water heater. The condensate from the rolls also flows back into the feed-water heater.

This rearrangement eliminates the use of live steam. At the same time the condensing engines develop their power at a water rate of about 20 lb. per kw-hr. No more men are used than formerly in the engine room, while the pulverized coal apparatus has enabled the plant to eliminate two firemen, one on each shift. At present

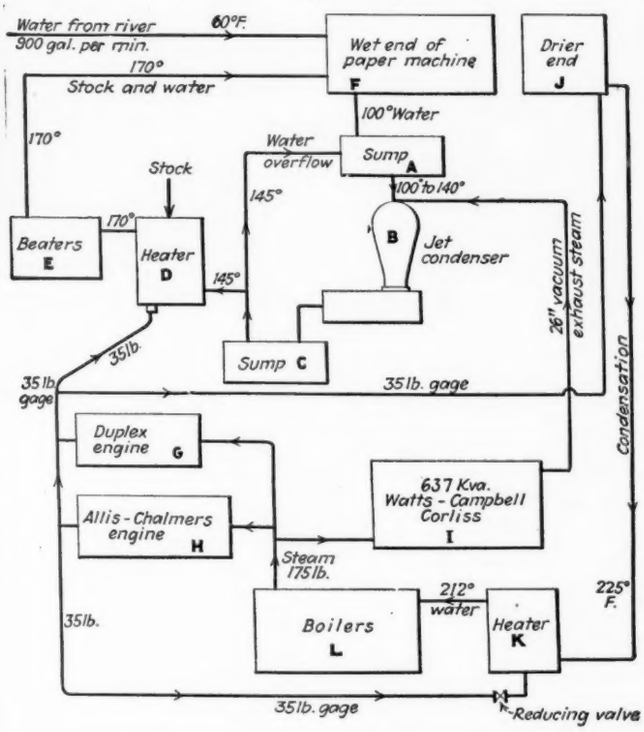


Fig. 4—Present hook-up with the engines cooling water used in the paper mill

two firemen are used during the day watch and one at night. The second day man is actually spending his time in ash removal.

With the other equipment a coal handling system was installed. The coal car is received on a trestle and the coal dumped into a crusher. After being crushed, the coal drops into the boot of a vertical bucket elevator, which dumps it into a horizontal drag chain. This drags the coal to the boiler house, where it is dumped into one of two 50-ton steel hoppers located above the firing aisle. The pulverizers, which are on a platform in front of the boilers, receive the coal from the hopper directly above.

It has been found that the coal, if put into the pulverizer wet, becomes more or less difficult to handle. The engineer built an air heater around the breeching of the larger boiler in order to dry the coal in the pulverizer. This heater, a box-shaped steel jacket about the breeching, is provided with baffle plates so that air flows along the breeching eight times before it goes to the pulverizer fan. The air temperature goes to around 145 deg. F., although on full boiler load it goes considerably higher.

Air-cooled walls are used on the furnace of the 5,800-sq.ft. boiler. This consists of an air space between the firebrick lining and the red brick; interlocking tile are inserted at intervals to hold the lining. The air enters about six feet above the boiler room floor, through a series of slots, and reaches the furnace at floor level. The tile apparently fails to meet existing conditions, and the interlocks break off. This permits the walls to give way, and at present a plastic lining is being built to replace the firebrick.

The coal enters at the tops of the Dutch ovens, and the flame turns up sharply along the front wall. This has damaged the wall, and at the same time the flame does not reach the rear ends of the front rows of tubes. In effect a part of the heating surface is not being used. It is planned to introduce the coal at two points on the front wall of the Dutch oven. It is thought that by increasing the fan pressure the flames will penetrate to the back of the furnace and serve to protect the front walls.

The rearrangement of the plant has resulted in the elimination of the purchased electricity without increasing the cost of the coal burned. Much of this is due, of course, to the use of a cheap grade of coal, but an examination of the new process connections will show where a decided saving in costs was made in the paper mill itself.

Patent Applications and How to Overcome Obstacles

By C. J. Cottrell

THE United States government grants patents for inventions to inventors who apply therefor and meet all requirements of the patent laws. Such a grant is monopolistic in nature and gives the patentee the exclusive right to make, use and sell the invention described in the patent. But the patent laws are rigid, and usually the path of the inventor who seeks such a monopoly is not smooth, and is filled with pitfalls, hazards, and numerous obstacles which must be overcome. A brief discussion of some of the precautions that should be taken, and the procedure necessary to obtain a patent, will be helpful to prospective applicants.

The applicant must be the first inventor, regardless of whether he knows or believes himself to be or not. Consequently, it behooves the inventor to make a record of his date of conception of the invention, the date of making his first drawing and written disclosure, the date when he first disclosed the invention to others, and the date of making his first full-sized structure. Such information should be put into a form so that it may be available as legal evidence to prove the dates alleged. A good way of doing this is to make drawings and a written description, and show them to two persons who should sign the papers as witnesses before a notary public.

Provisions To Be Noted

The law further states that the invention shall not have been described in a printed publication or used in public for more than two years prior to making application for patent. These provisions should be carefully noted, for often inventors are prone to publish the details of their inventions in magazines and other publications, and then delay more than two years before making application for patent.

The application for patent consists of a petition to the Commissioner of Patents, a specification describing the invention in detail, an oath, and a drawing executed by a skilled draftsman, showing all details of the invention. A model is not required. The specification is concluded by a number of claims which set forth concisely the structure which the applicant desires to protect by letters patent. The claims are the most important part of the patent, for they define the extent of the monopoly granted by the government. No patent is better or broader than its claims. While great care is required in the making of the drawing and the drafting of the specification, the claims require a peculiar skill which comes only as the result of experience.

Its Course After Filing

When the application is filed in the Patent Office, it is given a serial number, and the date of application is recorded. The drawings are sent for approval by the chief draftsman, and then the complete application is assigned to the division in the Patent Office that specializes in the particular invention disclosed. The examiner, who is an expert in the type of inventions covered by the application, carefully notes the drawing to see if it properly discloses the invention, and then examines the petition, oath and specification for informalities. His next step is to consider the claims, and he studies each claim separately and makes a search through existing patents, domestic and foreign; through old magazines and books, and uses any information available to show that the applicant is not the first inventor. If he is successful in finding evidence that indicates prior invention by someone else, he writes a letter to the applicant stating his ground for rejection of the claims, and the applicant is allowed six months in which to respond and amend his application to overcome the examiner's rejection.

This procedure continues between the examiner and the applicant until the application contains only allowed claims. The examiner then passes the application to issue, and the applicant is allowed six months thereafter in which to pay the final fee of $20 to obtain his patent.

When Applications Conflict

Such is the procedure in the usual application, but consider the case in which there are two or more persons applying for patents on the same invention. In such a case a proceeding called an "interference" is instituted to determine which is the first inventor. Now, this is where the evidence of the two witnesses to the original description and drawing made by the inventor comes into play. If the inventor is really the first inventor, he has first-class evidence to substantiate his claim. Interference proceedings are expensive, and many inventors lose out simply because they have not taken precautions to establish evidence which proves that they are the first inventors.

There is many a slip betwixt the cup and lip in patent cases, and no inventor should undertake to prosecute an application for patent by himself. Proper presentation and prosecution of applications require the services of patent attorneys who are skilled in that highly specialized branch of law and engineering.

Curing Resonant Vibration in Turbine Units

By T. C. Rathbone
Engineer, Westinghouse Electric & Manufacturing Company

The first article on vibration of turbine foundations dealt with the efforts made by designers to avoid resonance. This article discusses methods of correcting resonance conditions when encountered in operating units.

WHEN a turbine unit has been built and placed in service and resonance is encountered, there are certain cures at our disposal which may be quite effective.

A curve showing amplitudes of vibration throughout the speed range is called a *resonance curve*. It serves as a powerful tool in diagnosing the resonance characteristics on any turbine installation.

Fig. 1 is a resonance curve of both vertical and lateral vibration observed at the pedestal of a 40,000-kw. installation while bringing the unit up to speed. The variation of amplitudes with speed is characteristic. Below 700 r.p.m. there were a number of additional resonance points, not shown. There was appreciable initial unbalance in the rotating element coming up to speed, but it is interesting to note that at 1,075 r.p.m. there was almost an entire absence of vibration. The rotating element could have possessed great unbalance without objectionable vibration at this point.

It was unfortunate that the operating speed was not 1,075 r.p.m. A major vertical resonance peak occurs at 1,450 r.p.m., which would have been a very unfavorable speed for operation. A minor vertical resonance occurs at about 1,720 r.p.m., and the vertical vibration falls off slightly going through 1,800 r.p.m., the operating speed, while the lateral is rapidly increasing. The characteristics of this curve at running speed are unfavorable, another "valley" such as at 1,075 r.p.m. being desired at this point. Attempts so far to change the elastic scale at the support of this particular unit have not been successful, probably because the deflection changes in the pedestal support so far attempted, are not of sufficient magnitude compared with the over-all deflection of the structure.

In Fig. 2 are shown resonance curves of a 30,000-kw. double-exhaust unit of the type having the bearings integral with the cylinder and the cylinder supported on the bedplate by chairs. The unit had been subject to a large vibratory disturbance of a variable character, particularly in the vertical direction at the thrust end. The spindle itself had been held entirely responsible, but balancing soon proved fruitless. The resonance curves 1 and 2 demonstrated an unfavorable mode of vibration at running speed. The slope of the curve at 1,800 r.p.m. showed that small changes in the mode of vibration would cause large changes in amplitudes, and these mode changes were frequent, usually accompanying changes in load. Methods of changing the elastic scale of the foundation appeared to be quite difficult to accomplish, and in this case it was easier to change the elastic scale between the machine and the turbine bedplate.

The relatively rigid chairs were replaced with light posts, as shown in Fig. 3. A further increase of elastic deflection was obtained because of the more concentrated loading on top of the bedplate. After installing the post supports, another set of resonance curves was taken. Curves 3 and 4, Fig. 2, taken with both increasing and decreasing speed, show the decisive result. The peak at 1,250 r.p.m. was not perceptibly changed, probably because the mode of vibration at this speed was of a fundamental nature nearly independent of the particular detail in the matter of cylinder supports.

Vibration Reduced by Changing Supports

The next higher critical, which had been somewhere above 1,850 r.p.m., suffered a drastic displacement occurring now at about 1,550 r.p.m. At 1,800 r.p.m. the vibration is small and decreasing, the valley not being reached at 1,850. This suggests that a further decrease in the stiffness of struts would have resulted in still more favorable running.

The reduction in vibration during the time the four posts were being installed, is graphically shown in Fig. 4. The operation on posts continues entirely satisfactory, with no trace of the cyclic vibration spells that previously had occurred on load changes and that had at first been attributed entirely to the turbine spindle. No change whatever was made in the spindle to eliminate the unsatisfactory condition.

Some time previous to the case just cited, an experience was had with another machine which was subject to periodic vibration spells at about twenty-minute intervals. The trouble was most baffling, but every indication pointed to some fault in the spindle. Nearly all attention had been focused in this direction. A new spindle was supplied, on which the extreme was reached in the matter of rigidity and joint strength. Elaborate

thermal tests were carried out with the spindle in the balancing machine, which proved the spindle to be almost immune as regards distortions from violent temperature changes. The new spindle was then put in service, and it behaved, if anything, worse than the original.

Serious study was then made of the resonance characteristics of the installation, especially in the matter of nodal vibration, under the direction of W. B. Flanders. This investigation soon disclosed a peculiar mode of vibration by which great amplitudes were easily maintained. The elastic scale of the supports at one end was changed, as suggested by the mode of vibration. The result was most spectacular. While the vibration was reduced to within reasonable amounts, the periodic phenomena persisted. This was eliminated by relieving a side impact at the supports and by changing the elastic support of the steam chest.

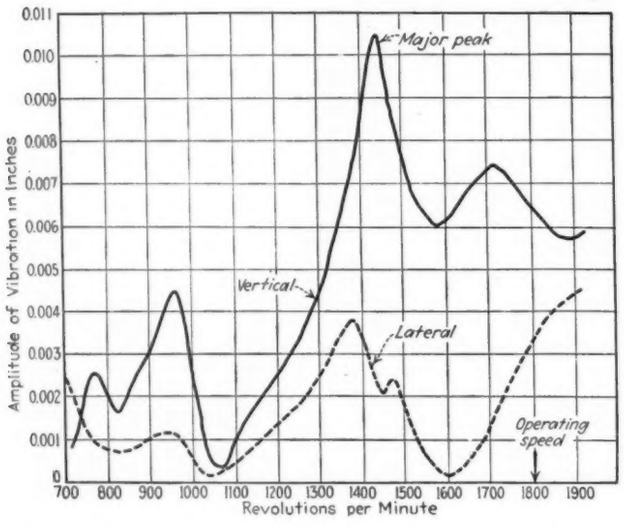


Fig. 1—Resonance curves showing unfavorable vibration characteristics at the operating speed of a 40,000-kw. turbine

Thus, through lack of knowledge of the complex features that may attend resonant conditions, great needless expense was incurred by the manufacturer, and a long period of needless outage by the power company.

Effect of Change in Foundation Loading

It has been found that the vibration may be affected by the readjustment of the loading of the unit on the foundation. When the unit is assembled, the attempt is made by precise leveling to proportion the loading in accordance with a definite plan.

If a column becomes unduly heated, this distribution of loading may be changed to a considerable extent. The resonance characteristics may likewise be changed, because of the variation of the elastic scale.

Undue heating of horizontal members may bring about a twisting, causing misalignment which can, in turn, set up vibration.

The turbine- and engine-room flooring is particularly susceptible to vibration. When this is in the vertical direction, it is most noticeable to an observer standing on the floor. Lateral vibration does not produce the same physiological effect. Vertical floor vibrations at a frequency of 30 cycles per second becomes distinctly noticeable when they reach 0.0003 to 0.0007 in. in amplitude and are disagreeable and objectionable at 0.004 in. At about 0.008 in. or over, the inertia of the eyeballs is brought into play, and vision becomes blurred when standing on the heels. The nervous system is extremely sensitive to mechanical vibrations—so much so that vibration that cannot be measured by any ordinary means are easily perceptible.

Floor Vibrations

If a vertical vibration at 30 cycles per second is sinusoidal, the velocity of a weight falling through gravity becomes just equal to the maximum velocity of the vibratory motion when the double amplitude is 0.043 in. Below this amplitude a weight lying on the floor should move with the floor, but above this point the floor will move downward faster than the weight and strike it on the return stroke, causing the object to rattle and "walk away." As vibrations ordinarily encountered are not purely sinusoidal, this critical amplitude may be much smaller than stated.

Light flooring vibrates in definite modes which are easily demonstrated. Fig. 5 (*a*) shows the result of plotting vertical amplitudes of the floor contiguous to a 40,000-kw. unit and drawing contours through points of equal amplitudes. The result indicates the similarity to the well-known Chladni figures. In this particular instance the operator's desk was over an antinode, as was a portion of the gage panel. The effect of placing about 3,000 lb. dead weight at one of the antinodes was instantaneous, the reduction in vibration being evident in Fig. 5 (*b*). The turbine itself was in fairly good balance. The floor supports in this particular case were tied directly to the turbine foundation itself, notwithstanding the apparent isolation indicated in the figure.

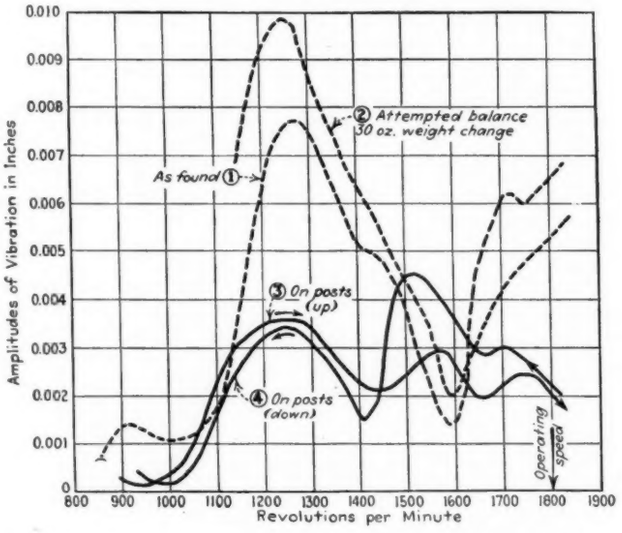


Fig. 2—Resonance curves of vertical vibration taken on a 30,000-kw. turbine before and after replacing chair supports by light posts

Avoiding Resonance Tendencies by Design

From the foregoing it is apparent that many evils exist, tending to prevent smooth operation, and these must be recognized by both the machine builder and the

foundation builder. It is clear that many of these evils cannot be avoided by analytical predetermination—that they are largely accidental in character.

The condition described as corrected by posts cannot by any means be said to indicate a fault of the turbine builder, nor can the foundation builder be blamed. Both exercised the best engineering judgment available. The resonant condition in this mode of vibration could not have been predicted from design, so we must simply admit its accidental nature and devise means to eliminate the trouble. In this case it happened to be easiest and cheapest to change the turbine supports. Unfortunately, this is not always the case.

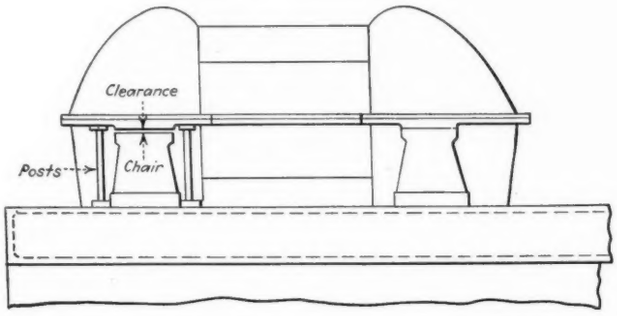


Fig. 3—Low-pressure cylinder supports replaced by posts to avoid resonance

With the fundamental principles of forced vibration in mind, we may state what characteristics, other than resonance considerations, a foundation may possess, tending to subdue the vibratory response. As the mass of the system is increased, the acceleration that the given force can impose is lessened, and hence the amplitude. It would be more proper to speak of the inertia moment rather than mass, as, to obtain the greatest benefit, the mass should be concentrated at strategic localities. This is the same as saying that the mass moment of inertia about the axis or node of vibration should be as great as is practically possible. From this point of view, a foundation with favorable lateral characteristics might be conceived as composed of a massive floor mounted on relatively slender posts.

Internal and External Friction Retards Vibration

The damping factor involves the resistance to vibratory motion offered by internal and external friction. Securing external friction by dampers is, of course, out of the question, although they may be used on minor parts.

Internal friction, sometimes called molecular or intercrystalline friction, is a property all materials have to a greater or lesser extent. The less the friction loss, for example, the longer will a bar of a given material continue to vibrate when struck a blow. The sustained notes of bells, tuning forks and the like demonstrate this point.

The riveted plates, joints, etc., in steel foundations are friction dampers to some extent, while it would appear that concrete possesses greater internal friction characteristics.

A portion of the periodic force is spent in straining the elastic structure. A given force manifestly cannot deflect a stiff member to the same extent it can a more yielding one. The modulus of elasticity alone is not the only factor to be considered, as a concrete member with a much lower combined modulus than steel, may have a greater stiffness by virtue of a greater area of its section.

Practical Considerations

The foregoing dynamic considerations are aside from the property of resonance except for the remarks on friction, as friction alone limits resonance amplitudes. There now remain to be considered certain practical features which are important in producing a satisfactory structure.

It has been an old practice to isolate a foundation carrying oscillating or rotating machinery from the rest of the plant, and it is not amiss to say here that the reasons for doing this are just as good today as they were in times past. High-frequency mechanical vibrations have a propensity for communicating their influence to surrounding floors and structures, even to remote points. Moreover, the rotating elements in starting up after a temporary shutdown may be in a slightly bent condition. If the rolling-over preparatory to bringing to speed occurs at a rate agreeing with the natural frequency of the structure in the lateral direction, heavy rocking may result, which becomes very objectionable when it can be communicated to the power-plant structure. Of course, good operation lies in avoiding rolling at the "rocking speed," but this is not always observed. Best engineering practice is secured by isolating the turbine-generator structure from the plant structure as far as possible, especially the floors. The latter should be supported entirely by individual columns, with a definite separation between the floor and top of foundation. A great deal of disagreeable vibration at the gage board and on hand rails and stairways, could be eliminated if this were strictly carried out.

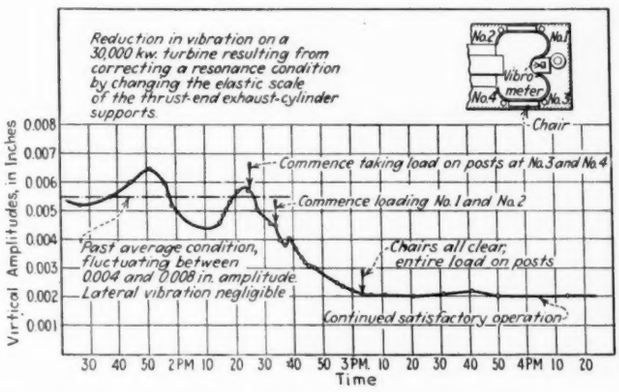

Reduction in vibration on a 30,000 kw. turbine resulting from correcting a resonance condition by changing the elastic scale of the thrust-end exhaust-cylinder supports
No.2
No.1
Vibrometer
No.4
No.3
Chair
Vertical Amplitudes, in Inches
0.008
0.007
0.006
0.005
0.004
0.003
0.002
0.001
Commence taking load on posts at No.3 and No.4
Commence loading No.1 and No.2
Past average condition, fluctuating between 0.004 and 0.008 in. amplitude. Lateral vibration negligible
Chairs all clear, entire load on posts
Continued satisfactory operation
30 40 50 2PM 10 20 30 40 50 3PM 10 20 30 40 50 4PM 10 20
Time

Fig. 4—Vertical vibration amplitudes while transferring load to post supports

Temperature effects have been mentioned. It is not uncommon to find parts of columns or girders maintained at temperatures of 140 deg. or more by direct radiation from uncovered pipes in the vicinity. Even a small drain or gage line bracketed to the column radiates in time a great amount of heat. The mere changes of air currents in the plant may temporarily result in a temperature expansion greater than refinements attempted in leveling the machine. The turbine-generator should not be subjected to such movements, especially as the

remedy is so obvious and relatively inexpensive. Structural steel, particularly when thoughtlessly covered with dull, dark paint, is a splendid absorber of radiant heat and may be heated to almost unbelievable temperatures. The least that can be done is to cover the important members (and nearly all may be important) with heat-insulating cork paint, preferably with a glossy white finish. Better still is the sensible practice now coming into usage of incasing the steelwork in concrete or covering with lagging. Some improvement in concrete foundations may be had by covering with glossy-white paint.

Finally, in arriving at a decision as to the particular type of design to be adopted for a proposed installation, it may prove profitable to make a survey of existing

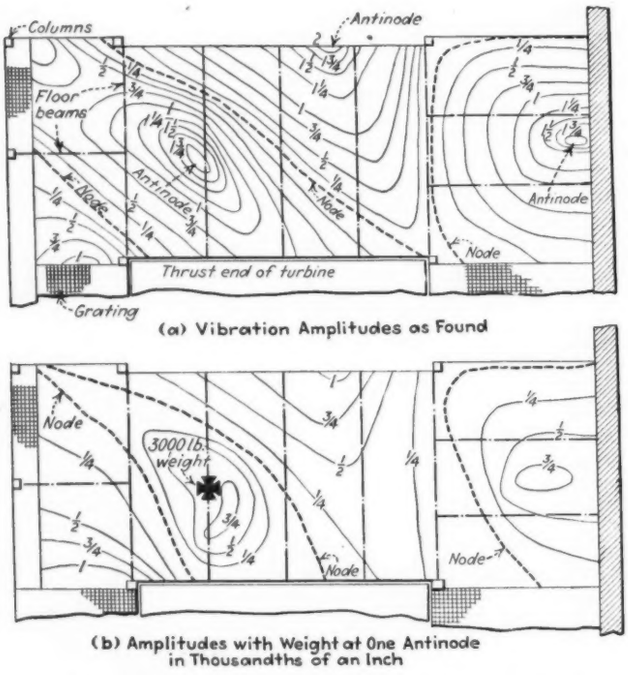
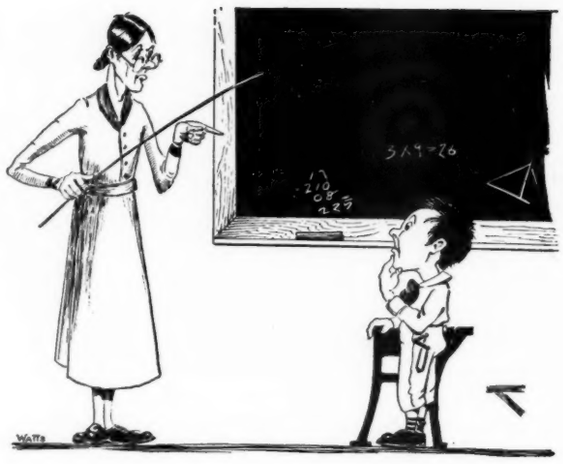


Fig. 5—Floor vibration map showing effect of changing mass

installations, comparing the history of vibration with types of foundation, elastic deflections, weight of the structure, etc. It is believed that there are important lessons to be learned and that there is ample room for the development of our present knowledge of vibration in complex structures.

THE LONGITUDINAL JOINTS IN THE SHELLS of unfired pressure vessels exceeding 48 in. in diameter are now permitted to be lap-riveted, according to revisions recently made to the A.S.M.E. rules for the construction of unfired pressure vessels, provided the following provisions are met: The operating pressure shall not exceed 50 lb. per sq.in. The plate thickness shall be at least 1.8 times the required plate thickness. Telltale holes $\frac{1}{8}$ to $\frac{1}{4}$ in. in diameter shall be drilled to a depth of at least 60 per cent of the required plate thickness in those surfaces opposite the surfaces subjected to wear or other deterioration, with the spacing of the holes not over 2 ft. apart.



What Do You Know?

BY L. H. MORRISON

The answers are on page 654

Ques. 1—Suppose you had an 8-in. pipe 20 ft. long with ends capped and filled with air at 100 lb. pressure. If one cap is removed so that the air can rush out, will the inside pressure reach that of the atmosphere, stay above it or go below it?

Ques. 2—In what field is rape oil used as a lubricant?

Ques. 3—What should be the velocity of steam flow in the line to a steam engine?

Ques. 4—In a reciprocating compressor the compression is nearer to isothermal than adiabatic; but a turbo compressor may have a compression line above the adiabatic. What is the reason?

Ques. 5—Would it be economical for a coal mine to use oil engines for power to operate the mine?

Ques. 6—Is it possible to use a refrigerating machine to heat a house?

Ques. 7—What is meant by clearance of an engine?

Ques. 8—Is it possible to increase the speed of direct-current motors used to drive fans? If so, how is it done?

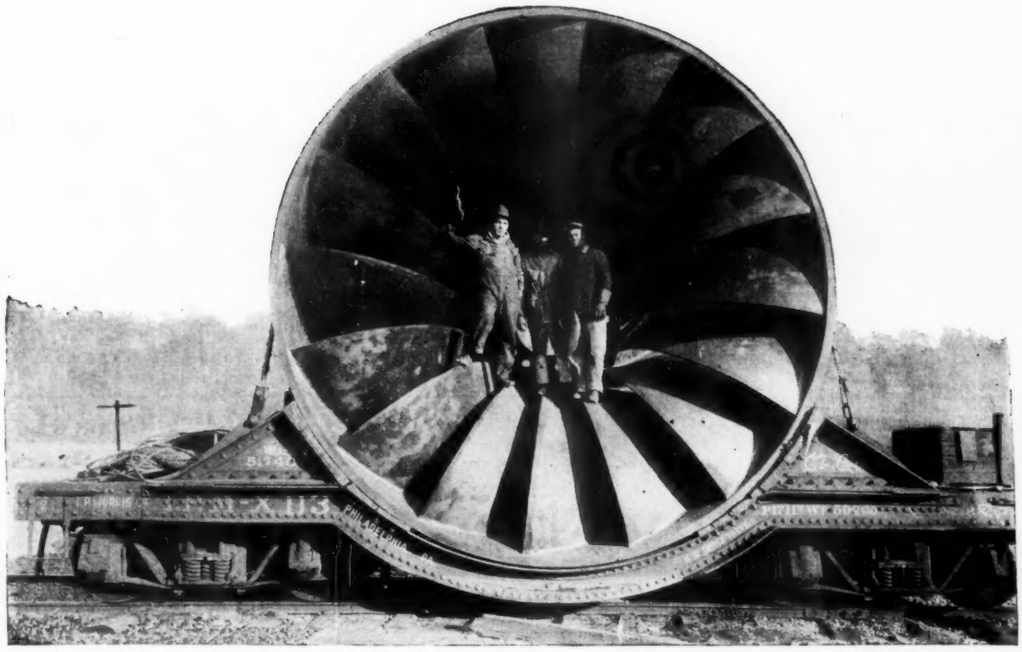
Ques. 9—How much lap has the steam valve of a long-range double-eccentric Corliss engine when the wrist-plate is in mid-position?

Ques. 10—The specific gravity of an oil at 60 deg. F. is 0.878. How do you find the Baumé reading?

The answers, to be found on another page, are those deemed correct by the editor, but readers are invited to send in corrections when the editor has been wrong.

Then and Now

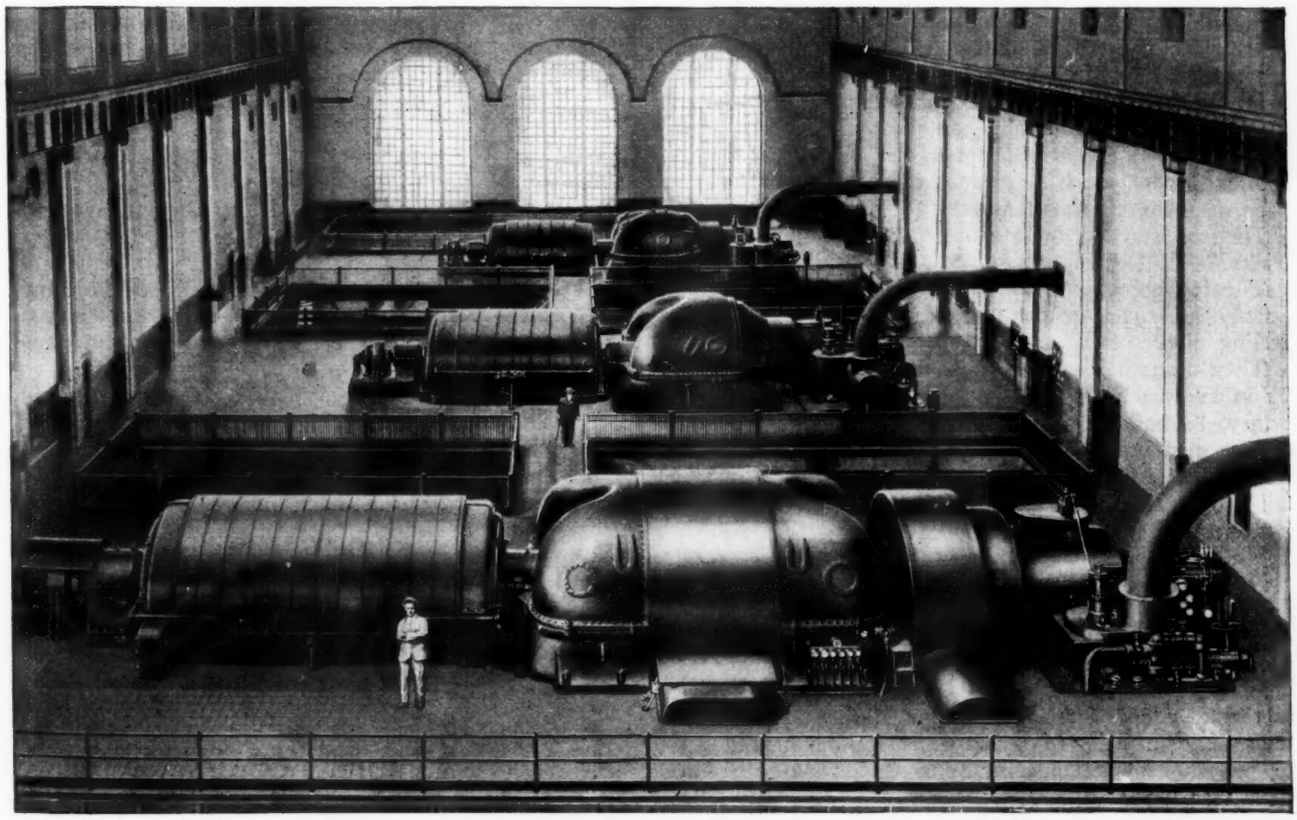
John Stevens stands with Watt and other pioneers of engineering. Read his romantic story as told by A. D. Turnbull in the April 17 issue. Following this historical appetizer comes a square meal of practical information for the man who faces present-day problems of plant operation.

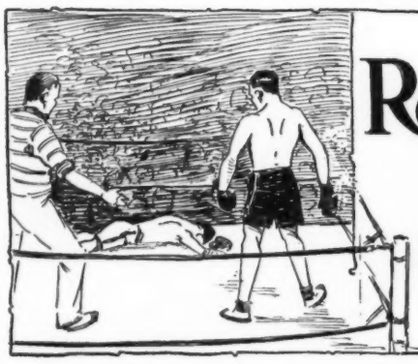


Some More Big Units

Above—Waterwheel, which is 16 ft. diameter, 10 ft. 3 in. high, weighs 130,000 lb., and rated at 50,000 hp., being shipped from the I. P. Morris Corporation works in Philadelphia to the Upper Tallassee development of the Alabama Power Company

Below—Three Allis-Chalmers steam-turbine units in the Public Service Company of Northern Illinois plant at Waukegan, Ill. These units have a rating of 25,000, 35,000 and 50,000 kw. respectively. Steam conditions are 600 lb. and 725 deg. F. total temperature





Reminiscences of an Engineer

By Hubert E. Collins

Murphy Nails the Job

JACK MURPHY finished breaking and pushing back his fire and covered the dead plate for coking with vigorous heaves of his shoulders. He then slammed shut the firedoor of his tubular boiler. Vigorous and slammed are words fitting Jack and his manner, for he attacked with zest every detail of his job as operating engineer. He was young and loved his work.

Born and raised in the Pennsylvania hills, of Irish-American parentage, he had the light blue eyes of the Celt. A large frame, bony face and fists, a devil-may-care manner of looking one in the eye, attracted and held one's gaze. He had barely reached the age of twenty. In spite of his lack of years his employers gave him full charge of boiler and engine in the power plant of the factory. In the lodge room of the engineer's association Jack discoursed on the rules for figuring the safety-valve weight, area, proper pressure, distance of weight from fulcrum, and sketched valve gears. He always started the arguments more politely called discussions, from which he gleaned more and more knowledge of his chosen profession.

He was startled by a voice, "Hello, Jack! How's tricks?"

Turning about, he met the gaze of his pal and confidant, Bill. Jack grinned at his friend and said, "I am feeling fine."

Then assuming a mysterious, happy mien, he asked, "You know what?" Without waiting a reply he continued, "I had a dream last night, and in it I met on the street a horse that threatened to run me down. I wrestled and threw it down, then picked it up by the tail and threw it over a fence, out of the way. That is how strong I feel this morning."

"Bully for you," said Bill.

Now, be it known, our young friend Jack was a pugilist of local repute. With his natural strength increased by the training from his work with the fire shovel, he had met and defeated the best in all the neighboring mills, acquiring skill until he was hailed as the "Champ." The great John L. was then touring the country, offering to pay anyone a good sum of money to stand up before him for four rounds. One of the sparring partners of the "big feller" also agreed to meet those who did not feel equal to his chief, and for this one could collect five dollars if one successfully withstood the beating one would receive in four sessions of three minutes—or longer if the local man hung on. Jack had decided to go to Philadelphia and meet this trainer as part of the show of the evening. The date was to be the evening of the day on which we meet Jack in this story.

The friends of Jack filled a coach on the train to Philadelphia that momentous afternoon. There was much skylarking with Jack in the lead, with loud and noisy discussion of the coming event. Slight heed was paid one boss in the party, who let drop the information he would pay an engineer more wages than anyone in that section received, to come with him and do as he was told and ask no questions. He gave out no details and was forgotten in the excitement of the approaching fight.

Arriving at the hall in Philadelphia, Jack and his friends found an excited throng pouring into the place. It is not the purpose of this story to describe the fight which won prominence and acclaim for Jack. After Sullivan had disposed of his man in the expected manner, he introduced his sparring partner in a booming voice. Jack hastily stripped off his shirt and entered the ring to answer the challenge. Those not in the know felt that the boy would be annihilated in short order.

Suffice it to say, he won by remaining on his feet and scoring a knockdown. He had not secured his victory without punishment, for the flesh on his chest was puffed up, lips cut, mouth swollen. But he carried off the prize money and a greater amount of glory. He had tossed the horse over the fence.

His cuts and bruises were forgotten as his mind reverted to the engineer's job offered by the boss of the rolling mill. What attracted him more than anything was the mystery about it. Why did they want someone with nerve, who would obey orders and ask no questions? Jack felt that the money would make it a step forward in his career as an engineer, with mystery and hint of danger.

He was taken into the mill and shown a rolling engine. This was one of the largest of the time, with two

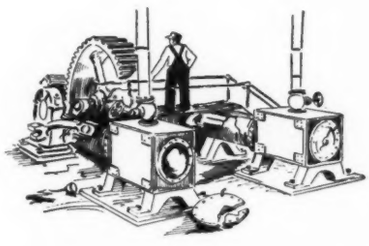
cylinders, each attached to one end of the heavy engine shaft on which the rolls were. This machine seemed to have been wrecked, and Jack was told to take charge of the reconditioning. He was told that he must put it in first-class shape and then come to the boss for further orders.

Long hours they worked lifting the shaft and rolls out of the bearings with block and fall, chocking on blocks as they rebabbitted bearing shells, scraping and grooving them as well as looking to the alignment of cylinders at right angles to the shaft. After ten days of chipping and scraping, the engine was ready.

With the plant assembled, the boilers were gotten under steam and the newly conditioned engine turned over at reduced speed to work in the bearings and adjust every bolt and nut to take strain. The boss ordered that full steam be on the boilers in the morning and that Jack be prepared for a trial under orders which were to be obeyed implicitly and without question.

Everyone left the rolling room except the boss, Jack and a crew that was working up some steel or iron to run through the rolls. Jack worked his engine a few times, saw that all was as he wished it, then nodded to the boss that he was ready.

The boss motioned to the iron workers and they dragged red-hot metal into place, although Jack could not see what it was. Suddenly, the boss yelled, "Give it to her wide open." With that command Jack threw full gear forward and jerked the lever throttle wide open. With a grinding roar the rolls revolved at full speed, then came a deafening crash as a mass of metal struck them. Following the crash of metal came a greater one as rolls and shaft rose from the bearings, with holding-down bolts flying in all directions. Up leaped the heavy mass, while the connecting rods twisted and broke from their connections, loosened pistons shot through cylinder heads and a blinding roaring rush of steam filled the room. Automatically, Jack closed the throttle; miraculously, he had escaped hurt. Soon there was quiet where bedlam and pandemonium had been. Jack braced himself for a call-down for some mistake he thought he had made. The boss came rushing to him and asked, "Are you all right?" That was his only comment, no censure; he was content at Jack's assurance, "Sure! I am all right."



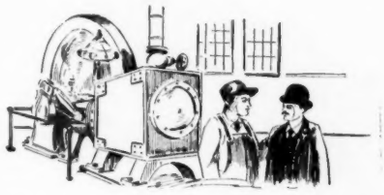
Then the boss brought in the designing engineer, they called for men, and the start was made to clear up the wreck. Valiantly the men worked for weeks, first clearing up the wreck while fragments were inspected as fractures and measurements made. New engine frames were cast and machined; the whole engine was rebuilt. Apparently, the bearings had been the weak spot. After several weeks of intensive labor, the engine was reassembled, tested and declared ready for work again.

Again Jack stood at the throttle and reversing lever; again came the command, "Full steam ahead." This time the mainshaft and rolls were held in place by bolts of sufficient strength, and Jack listened with satisfaction to the steady roar and crash of the rolls.

Thus was inaugurated the manufacture of the first wire nails made in the world. Thus was a nervy young operating engineer the principal human instrument in the start of the industry. Murphy had literally nailed his job.

At the start of this new industry the designers decided the best way to get a perfect machine was to try it out—if a man with nerve and fidelity to orders could be found to do the testing. The boss found him in the engine room close by, saw him tried in the prize ring against a seasoned pug.

Murphy had a job in this mill as long as he wished, but he grew more ambitious with years and left the scene of his early test in another year. He loved hard jobs and operated one after another the plants of power houses in the Metropolitan Districts. These plants were past their prime when he took them, were headed for the scrap heap, as the companies were installing larger and more modern units. Wonders of operating were performed as the owners refused to rebuild the old. No less than four such plants received the ministration of this man, and always he had the nerve to fill the bill. Today he follows his chosen work in a most modern plant where the almost silent turbine can remind him of the past only by contrast.



The romance of the old power plants is lost in the silent efficiencies of the present. As Jack gazes with undimmed eye across the reaches of beautiful Cayuga Lake, he surely has a faint longing for the old days.

He has seen real romance in the engine room; he no doubt finds it still, for he is that way.

Cutting In of Boilers

To cut in a boiler, or put it on the line after it has been out of service, is to place it in free communication with other boilers that are under steam.

In cutting in a boiler that has been idle, the stop valve should be kept closed until the steam pressure in the boiler has risen to the value that is prevailing at the time in the steam header to which the boiler is to be connected.

It is not correct to bring the pressure to within a few pounds of that in the main, for it is important that the pressures should be the same or as near the same as the different gages indicate. When the gages indicate the same, the boiler stop valve should be opened slowly to permit the small outstanding difference of pressure to become equalized without shock.

If there is any evidence of disturbance in the boiler or piping, as indicated by snapping or pounding or by abnormal vibration of the boiler, the stop valve should be immediately closed.

If there must be a difference of pressure it is safer to have the pressure in the boiler to be cut in a little higher than the pressure in the main rather than lower, because steam will then flow from the boiler out into the main instead of in the opposite direction. However, it is much better to have both equal.

Quebec Advances Rapidly with Water-Power Development

Chelsea water-power plant of the Gatineau Power Company; ultimate capacity 170,000 horsepower

Has Estimated Total of Over Thirteen Million Horsepower of Which Over Two Million Have Been Developed

By E. G. Wilson

THE influence of water power upon the trend and expansion of industrial development in the province of Quebec is becoming more and more marked, and is destined to play an incalculably important part in the greater development which is now assured for this section of Canada. The total available water-power resources of Quebec are estimated to be 8,459,000 hp. under conditions of ordinary minimum flow, or 13,064,000 hp. ordinarily available for six months of the year. These totals include the figures of power available at sites that have been developed and where installations of 2,165,443 hp. have been made. With the general relationship existing between installation and available resources, this development represents probably about 13 per cent of the total resources of the province.

With from two to two and a half million horsepower available in the reach extending from the Ontario boundary to the harbor of Montreal, the St. Lawrence is the outstanding power river. This power is possible of economic development in two concentrated reaches, the first embracing the Coteau, Cedars and Cascades Rapids between Lake St. Louis and St. Francis, and the second, the Lachine Rapids between Lake St. Louis and La Prairie Basin, above Montreal. These resources, so far, have been utilized to a comparatively small extent, involving a total installation of only 275,000 hp. at the Cedars and Lachine Rapids and along the Soulanges and Lachine Canal. A move is under way at present to develop 500,000 hp. in the reach between Lake St. Francis and Lake St. Louis. The project has strong financial backing, and as soon as permission has been granted by the federal and Quebec governments the work will probably begin.

The Ottawa River and its Quebec tributaries provide power possibilities of from 1,000,000 to 1,600,000 hp. On the Ottawa from Lake Temiskaming to Pointe Fortune, which forms the boundary between Ontario and Quebec, there are a number of large and important power sites which are shared by the two provinces and which total from 570,000 to 950,000 hp. Above Lake Temiskaming, on the upper Ottawa and on the part known as the Quinze River, there are powers totaling 90,000 to 220,000 horsepower.

Among the tributaries of the Ottawa River the Gatineau is outstanding, with continuous power possibilities in excess of 400,000 hp. It is on this river that the Gatineau Power Company is carrying out its huge power project. Two plants were built last year, one at Chelsea and the other at Farmers Rapids. At the Chelsea plant three 34,000-hp. units have been installed. Provision remains for two further units which will give the plant a total capacity of 170,000 hp. At the Farmers Rapids

development three 24,000-hp. units were put into operation last year, and provision has been made for the addition of two further units which will give the plant an ultimate capacity of 120,000 hp. About 27 miles above Chelsea the company has under construction a third plant at Paugan Falls. Here six units, each of 34,000 hp. capacity are being installed and are expected to be ready for operation in September, 1928. A fourth plant at Nigger Rapids on the same river is contemplated for future development by the company when load conditions warrant.

The Saguenay is outstanding among the power rivers of Quebec and, with its immediate tributaries and rivers entering Lake St. John, has total resources of from 1,260,000 to 1,530,000 hp. Tributary to the Saguenay itself, the most important rivers are the Chicoutimi and Au Sable, which are largely developed, and the Shipshaw, having total resources of 88,000 hp., with two sites utilized and a number still awaiting development.

Most of the installation in Quebec is found in stations generating electrical energy for general distribution, while a considerable total is also accounted for in developments directly connected with the pulp and paper industry. The production of ground wood pulp and newsprint being the great power-consuming factors in the pulp and paper industry, the statement that the mills of Quebec produced over 52 per cent of the ground wood pulp and over 44 per cent of the newsprint manufactured in Canada during 1926, predicates an enormous use of hydraulic power.

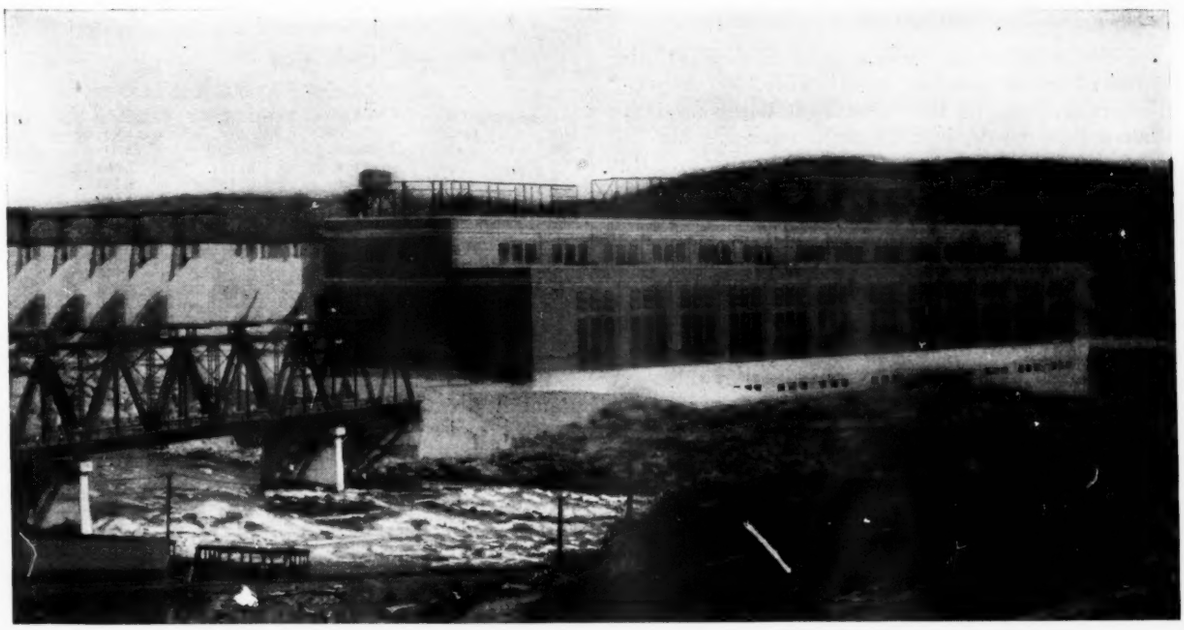
Hydraulic turbines of an aggregate capacity of 247,044 hp. are installed in connection with the pulp and paper mills, while an amount estimated to be in excess of 600,000 hp. is purchased from central electric stations. Of the power installed by the mills, 147,266 hp. is direct connected to mill equipment and 94,778 hp. to electric generators. The total utilization of hydro-electric power in the mills is thus in the neighborhood of 700,000 horsepower.

The St. Maurice River is the largest present source of power in the province, 557,000 hp. being now installed at three sites. At Shawinigan Falls, the Shawinigan Water & Power Company has an installation of 191,500 hp., while it also controls a 120,000-hp. development at La Gabelle. In addition to these, the company secures power from a 176,000-hp. development at Grand Mere, owned by the Laurentide Power Company. During the last year Shawinigan placed in operation a plant of 4,000 hp. at Ste. Alban, on the Ste. Anne-de-la-Perade River, replacing a former plant damaged by floods. The company has also started work in connection with the installation of an additional 40,000-hp. unit in its No. 2 plant at Shawinigan Falls.

The same company carried out a most notable achievement last year in the completion of a 165,000-volt transmission line, 136 miles in length, through an almost entirely uninhabited territory, to bring power from the Isle Maligne station of the Due-Price Power Company on the Saguenay River to the City of Quebec. This line, which at present is the highest voltage line in operation in Canada, is designed to carry 100,000 hp. for the supply of large pulp and paper mills recently erected in the vicinity of Quebec City.

On the Saguenay River at Chute-a-Caron the Alcoa Power Company is building a plant that will have an ultimate capacity of 800,000 hp., while the Duke-Price Power Company has still two units to install in its Isle Maligne station to bring it to its ultimate designed capacity of 540,000 hp. One of these units will be installed this year.

Among projects or extensions under active construction may be mentioned a 65,000-hp. development by the Montreal Island Power Company on des Prairies River near Montreal; the addition of two 10,000-hp. units to the Canada Northern Power Company's plant on Quinze River, to be ready in July, 1928; and a 300-hp. plant by the Cie d'Enterprises Publiques near Riviere a Piere, Quebec, on the river of the same name.



Isle Maligne development of the Duke-Price Power Company on the Saguenay River has 540,000-horsepower plant

Tests to Determine Most Practical Type of Over-Fire Steam Jets

By H. K. Kugel

Deputy Smoke Commissioner, Cleveland, Ohio

THE Smoke Department of Cleveland has long been interested in the use of steam jets, and Col. E. H. Whitlock, Commissioner of Smoke Inspection, suggested to Prof. F. H. Vose, of Case School of Applied Science, that this subject might be worthy of further investigation. The latter therefore interested two senior students, John DuPerow and Edmund B. Bossart, in making certain tests along these lines as a subject for their graduation thesis. These were carried out during the winter and spring of 1927 in a laboratory rigged up in the old boiler room at Case School. The writer is indebted to these men for the information given herein.

The layout used is shown diagrammatically in Fig. 1 and consisted of apparatus for measuring air and measuring velocity, a steam nozzle and an air induction tube, the last two of which could be varied easily.

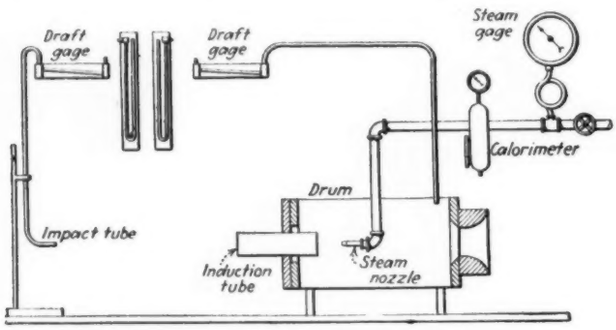


Fig. 1—Diagram of test apparatus

The main purpose of the steam jet, when used for smoke abatement work, is to furnish over-fire air and at the same time to cause enough turbulence to mix this air with the gases rising from the fuel. It was, therefore, advisable to study the amount of air induced as well as the velocity of the resultant mixture.

When the apparatus was in use, the steam jet caused a drop of static pressure in the drum. This caused air to flow through the standard flow nozzle at the end of the drum into the drum, where it combined with the jet and was carried out through the induction tube. A standard draft gage was used to obtain the drop in static pressure across the nozzle. The velocity was measured by an impact tube connected to a draft gage. The tube was movable, so that the distance from the nozzle could be varied at will. A pressure gage and a separating calorimeter were connected into the steam line.

The first thing was to determine the best size and shape of induction tube, which was accomplished by keeping the steam pressure fixed at 75 lb. gage and using a theoretical $\frac{1}{8}$-in. nozzle, at the same time changing the induction tube as desired. This tube could be moved backward or forward at will and was first placed so that the nozzle was two inches inside the mouth of the tube. It was then moved forward by one-inch increments. Air entrainment and velocity readings were taken at each position. Three different designs of tubes were tried as well as various lengths of 1-, 2-, 3- and 4-in. pipe. After the best nozzle position was determined, the steam pressure was varied from 15 lb. up to 120 lb. by 5-lb. increments.

After this the size and type of nozzle were varied, using a $\frac{1}{16}$-in. and a $\frac{1}{4}$-in. nozzle as well as one made by drilling a $\frac{1}{8}$-in. hole in an ordinary pipe plug.

Nozzle Should Be Outside Combining Tube

The usual practice in installing steam jets is to insert the jet inside the induction tube. The curves of Fig. 2 show that this is poor practice. The investigators state "that the best position for the nozzle is about one diameter of the combining tube outside the mouth of the combining tube." They explain the increased velocity obtained as follows: "First, since all velocities were measured from the nozzle mouth the farther the tube was placed from the nozzle the longer it served to guide the jet and prevent its dissociation. Second, more air was entrained. The fact that entrained air is necessary to give body to the jet stream was demonstrated by taking velocity readings both with and without entrained air.

EFFECT OF NOZZLE DISTANCE

Combining Tube—Dia., In.	Combining Tube—Length, In.	Lb. Air Entrained—Per Lb. Steam	Lb. Air Entrained—Per Second	Velocity in Ft. per Sec. at 36 In.	Distance from Nozzle, In.
2	10	11.4	0.194	2,980	0
2	10	11.6	0.198	3,240	1
2	10	11.6	0.189	3,480	2
3	10	13.97	0.237	2,265	—1
3	10	15.40	0.262	2,445	0
3	10	16.08	0.237	2,570	1
3	10	16.90	0.287	2,678	2
3	10	17.41	0.296	2,940	3
3	10	17.21	0.292	2,820	4

It was impossible to secure any indication of velocity when no air was allowed to entrain."

Fig. 3 shows that the pounds of air entrained per pound of steam varies inversely with the nozzle diameter. It also shows that the velocity increases with the nozzle diameter. From these curves it has been decided that the $\frac{1}{8}$-in. nozzle is probably the best all-round size to use, also that there is not a great deal of difference between the practical nozzle and the theoretical.

Fig. 4 shows the effect of tube diameter, based on the $\frac{1}{8}$-in. nozzle, 75-lb. pressure and 10-in. tube length. The authors deduce from this that the 2-in. tube is the best all-round size, but it seems that the 3-in. might be better as it gives considerably more air with comparatively little

loss in velocity. This can be seen from the table, which gives the pertinent figures for these two sizes. It is also interesting to note the marked difference in the amount of entrained air which is shown when the jet is placed close to or inside the combining tube.

One of the common faults of practical installations is that the jet is often not concentric with the combining tube. The tests show that both air entrainment and velocity are greatly reduced thereby. Rounding the entrance to the combining tube causes an increase in air

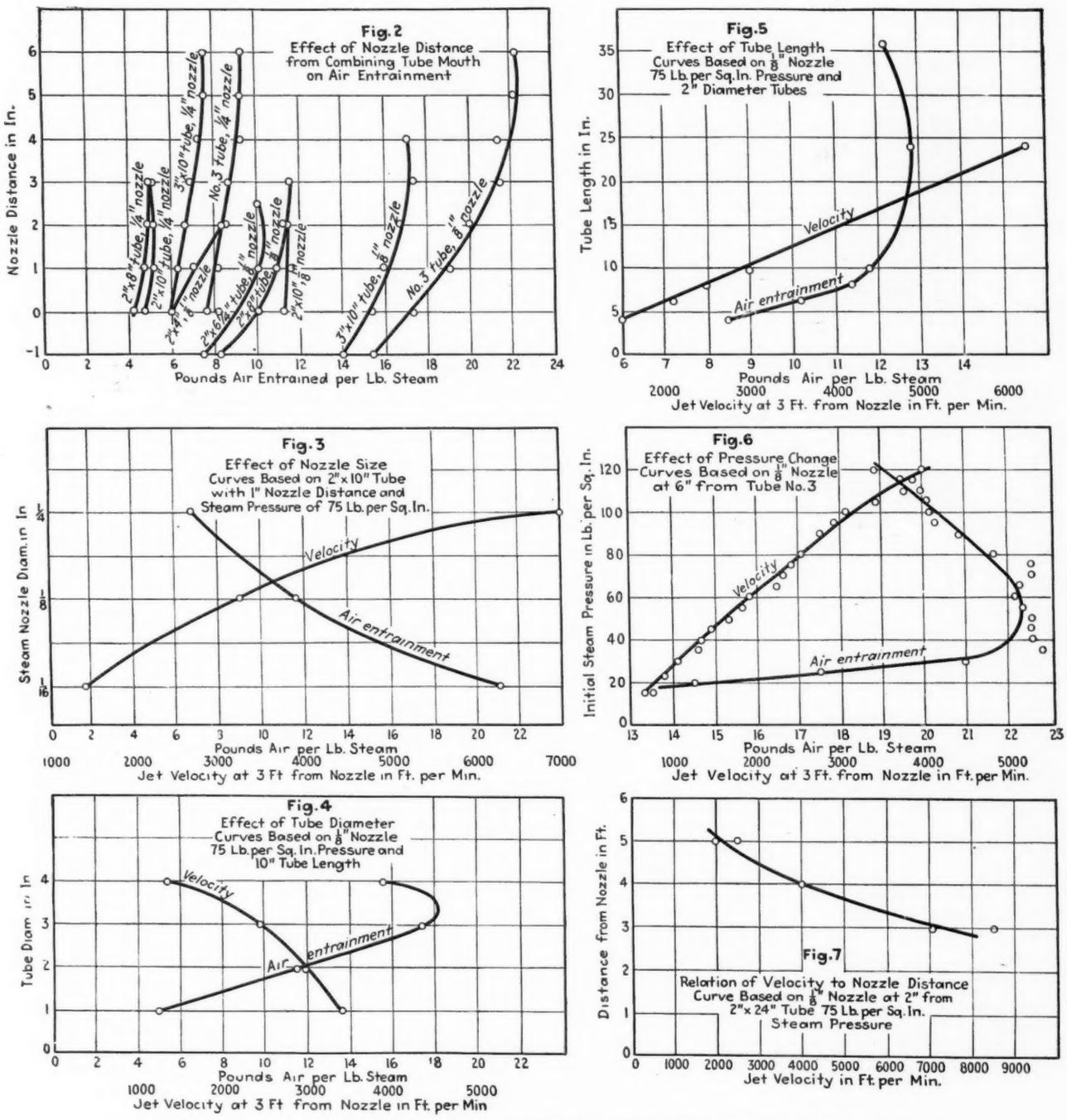


Fig. 2
Effect of Nozzle Distance from Combining Tube Mouth on Air Entrainment
Nozzle Distance in In.
Pounds Air Entrained per Lb. Steam
2"x8" tube, 1/4" nozzle
2"x10" tube, 1/4" nozzle
3"x10" tube, 1/4" nozzle
No. 3 tube, 1/4" nozzle
2"x10" tube, 1/8" nozzle
3"x10" tube, 1/8" nozzle
No. 3 tube, 1/8" nozzle
Fig. 5
Effect of Tube Length
Curves Based on 1/8" Nozzle
75 Lb. per Sq. In. Pressure and
2" Diameter Tubes
Tube Length in In.
Velocity
Air entrainment
Pounds Air per Lb. Steam
Jet Velocity at 3 Ft. from Nozzle in Ft. per Min.
Fig. 3
Effect of Nozzle Size
Curves Based on 2"x10" Tube
with 1" Nozzle Distance and
Steam Pressure of 75 Lb. per Sq. In.
Steam Nozzle Diam. in In.
Velocity
Air entrainment
Pounds Air per Lb. Steam
Jet Velocity at 3 Ft from Nozzle in Ft. per Min.
Fig. 6
Effect of Pressure Change
Curves Based on 1/8" Nozzle
at 6" from Tube No. 3
Initial Steam Pressure in Lb. per Sq. In.
Velocity
Air entrainment
Pounds Air per Lb. Steam
Jet Velocity at 3 Ft. from Nozzle in Ft. per Min.
Fig. 4
Effect of Tube Diameter
Curves Based on 1/8" Nozzle
75 Lb. per Sq. In. Pressure and
10" Tube Length
Tube Diam. in In.
Velocity
Air entrainment
Pounds Air per Lb. Steam
Jet Velocity at 3 Ft from Nozzle in Ft. per Min
Fig. 7
Relation of Velocity to Nozzle Distance
Curve Based on 1/8" Nozzle at 2" from
2"x 24" Tube 75 Lb. per Sq. In.
Steam Pressure
Distance from Nozzle in Ft.
Jet Velocity in Ft. per Min.

Figs. 2 to 7—Curves showing effect of different dimensional factors on jet velocity and quantity of air per pound of steam

In Fig. 5 will be seen the effect of tube length. In practice the length depends, of course, on the thickness of the furnace walls.

Fig. 6 shows the effect of varying pressures. The velocity increases, but the air entrainment falls off with pressures above 75 pounds.

entrainment of about 25 per cent, but it makes little improvement in velocity.

The results and conclusions are, of course, made from this series of tests only. Although they are not conclusive, they are indicative. It is hoped to carry on further tests this year.

ELECTRICAL
Operation and Maintenance

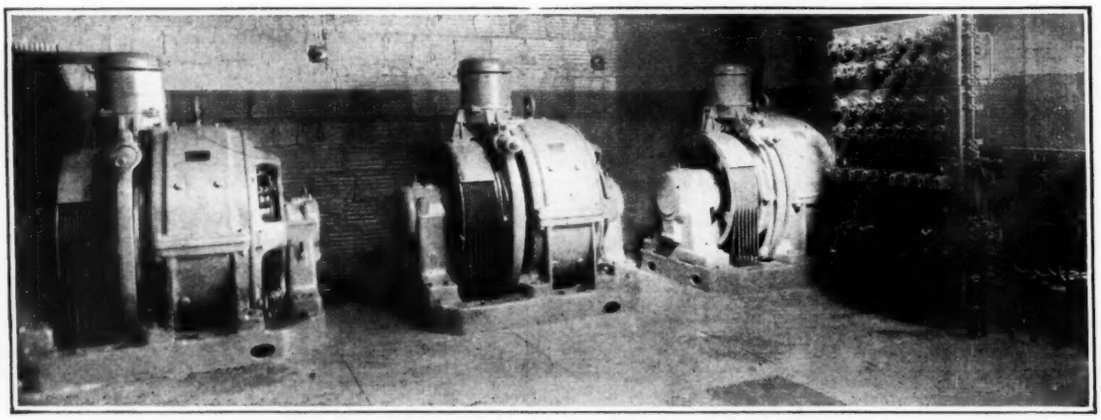


Fig. 1—Three full-wrap one-to-one direct traction machines

High Speed Elevators Make Landing Stops Automatically

by using inductor-type control and a signal system that tells the operator when to enter the car switch

By F. A. ANNETT
Editorial Staff, Power

AT THE high speed of 700 to 800 feet per minute at which modern passenger elevators are operated, it becomes exceedingly difficult for the operator to make accurate landings. The speed of the car makes it hard to recognize the floor numbers. At these speeds it is difficult for the operator to judge the distance within which the car can be stopped without going by the floor. This is true even with the best of operators, and with the average, much time is lost due to false stops. Even when false stops are few, time is lost owing to the operator's slowing the car down too soon, preparatory to making landing stops.

Where the landing doors are interlocked with the position of the car, the latter must be landed accurately before the doors can be opened. When the operator fails to stop the car level with the floor, time is lost while inching it into position. If the landing doors are not interlocked with the car position, it is necessary that the car be landed accurately to avoid accident due to passengers tripping. Then again, if the car is landed accurately the passengers will tend to move on and off more quickly, since they feel they can do so with safety.

High-speed accurate landing elevators, with snappy operating doors have the psychological effect of causing passengers to move quickly. If accurate landing can be assured, it is possible to render more and better service with a given number of elevators. All these factors may make it possible to reduce the number of elevators to provide this service. In high buildings the increase in renting space due to a reduction of one or two elevators adds considerable to the income from the building.

Accurate landing of the car is also an important factor in the maintenance of the elevator equipment. If it is stopped accurately at the landing on the first trial, the cables are bent only once as they pass over the sheave. If the car goes by the floor and is brought back on one trial, this will cause the cables to be bent three times in a short section near the sheave. The result of this increased bending of the cables in the sections near the sheave, corresponding to the position of the car at the landings, is evident, as it is at these sections that the cables first show signs of failing.

Inching the car puts a heavy duty on the magnet switches, particularly with rheostatic control. With nor-

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mal stopping the current in the direction switches is usually of a low value. When the car is moved a short distance to bring it level with the floor, the contactors may have to break a maximum current. This wear on the contactors can be avoided by accurate stopping of the car. The wear on the moving parts of the equipment, due to the increased number of operations, must also be considered. Most experienced elevator engineers can recall cases where an elevator has run satisfactorily with one operator. Then for some reason a change was made in operators after which the equipment gave no end of serious trouble. No doubt the equipment was not suited to the service, nevertheless it was possible for a good operator to get satisfactory service from it. These experiences are convincing evidence that the operator is an important factor in the wear and tear on elevator equipment.

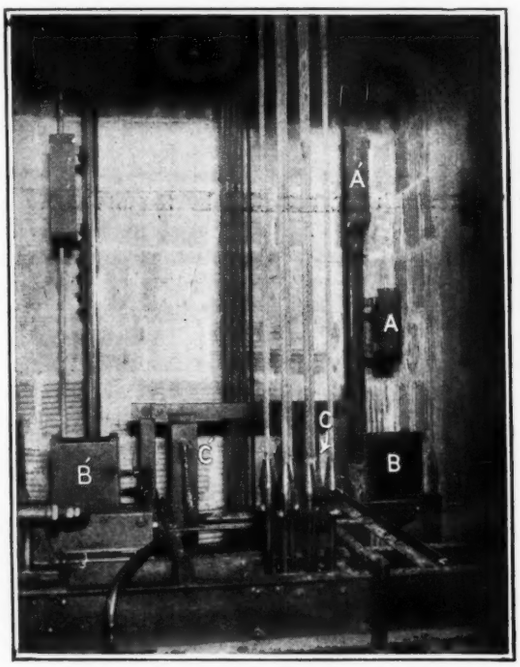

Fig. 2—View of top of the car and the rear of the hoistway

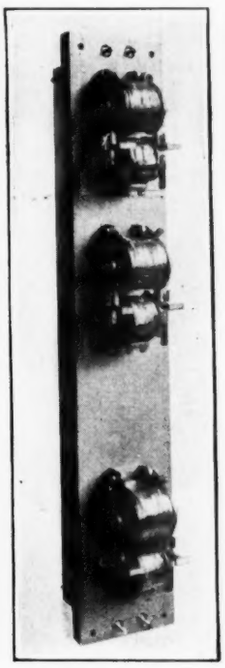

Fig. 3—Stopping inductor switch

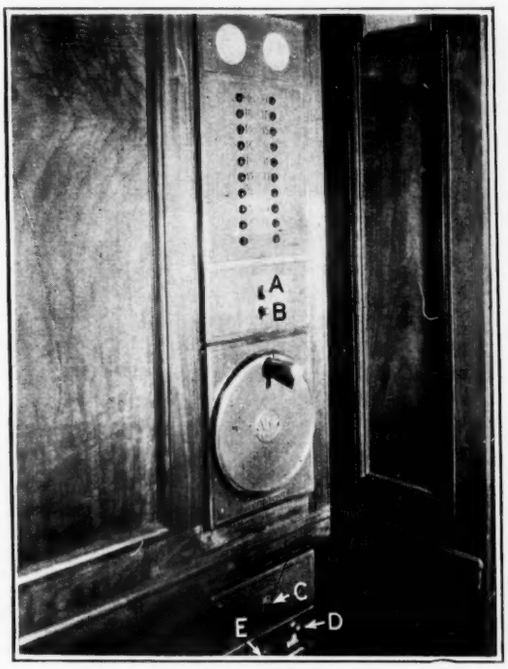

Fig. 4—Above the car switch are the preregister signal buttons

Automatic Stopping at Landings

During recent years considerable attention has been given to stopping the elevator car automatically at the landings and thus taking this function out of the hands of the operator. There is much to be said in favor of this practice, as already indicated. In addition, the operators are allowed more freedom to attend to the needs of the passengers. If their duties are made such that they can be performed without undue effort, they will be in a proper mental condition to give courteous treatment to the passengers. Hard operating doors, a poor signal system and a control that makes it difficult for the operators to make good landings are likely to be reflected in their attitude toward the passengers. Such conditions are important factors in the class of tenant that can be retained in a building. The public is being educated more and more to the idea of courteous service, and this is expected from elevator operators just as from the tenant at whose office they may call. If the passengers do not get such service, complaints and dissatisfied tenants result. The economic value of the latter is difficult to estimate.

Tendency Toward Automatic Control

The tendency in many types of industrial power controls is to make them as nearly automatic as possible, and there seems to be no good reason why this should not be the goal sought in elevator work. In fact, experience so far shows this is in general the most economic arrangement and will pay dividends on the additional investment.

In the 60 Broad Street Building, New York City, is an installation of three elevators with automatic landing control, which has many features of interest. The control is of the Westinghouse automatic inductor type, which is designed to bring the car to and stop it level with the floors with a minimum of time lost in the slowing-down operation. When the car comes into the signal zone, the operator centers the car switch, after which a rapid and smooth stopping operation is carried out automatically and brings the car-floor level with the landing.

The car is started in the usual manner by moving the car switch to the running position. For control of the motor Westinghouse variable-voltage control is used. This type of control lends itself to very close speed regulation over wide ranges of load, which is essential to accurate landing.

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With the inductor control all operations of automatically slowing down the car and stopping it accurately at the landings are accomplished without any mechanical contact between the parts of the control on the car and the stationary parts in the hoistway. Therefore, so far as the operation of the control in the hoistway is concerned, it is silent and not subject to wear.

In the hoistway, mounted on the counterweight guide

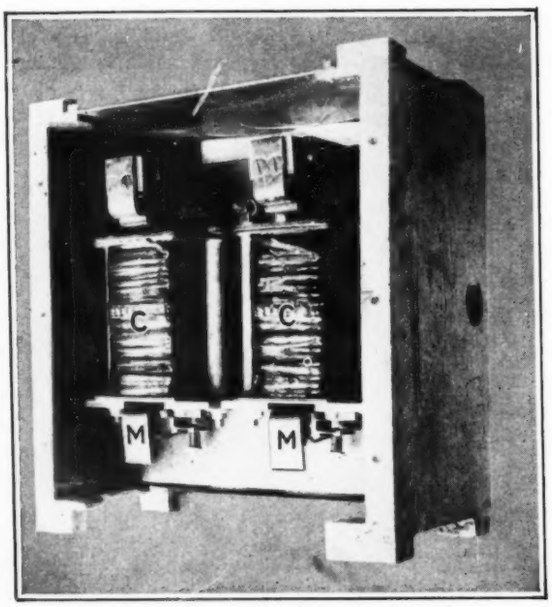

Fig. 5—Inductor switch with first and second slow-downs

rails, are what are known as inductor plates, such as shown at *A* and *A'*, Fig. 2. On top of the car are slow-down inductor switches *B* and stopping inductor switches *C*. These switches are totally inclosed in metal cases to protect them from dust and dirt. On the side of the cases next to the inductor plates non-magnetic material is used.

The inductor switch consists of a coil and magnet and a normally closed contact, Fig. 5. As shown in the figure, there are two inductor switches, one the first slow-down and the other the second slow-down. When the operator centers the car switch, the coils *C* become energized and the magnets *M* excited. When a magnet comes in front of its inductor plate, it is attracted and opens its contacts. Opening the contacts interrupts the circuit to the slow-down relay on the elevator-motor control board and decreases the car speed.

In Fig. 2 it will be seen that inductor plate *A* is out of line with *A'*. This allows No. 1 slow-down to function first, and as the car continues in motion the second slow-down inductor switch is operated by plates *A'*. Final stopping of the car is done by the stopping inductor, which contains three switches. This inductor switch is shown in Fig. 3 with the cover removed. The final slow-down and stopping are accomplished by an inductor plate, not shown in Fig. 2, which causes the stopping inductor switch *C* to function as the car approaches the floor.

The inductor plates in the hoistway are adjusted to give a minimum stopping distance and obtain a smooth and accurate stop. When floor-to-floor runs are made, the operator moves the car switch to the first running position and, when the car starts, immediately returns it to the off position. In this case the high-speed relays on the controller are not energized, so that the car reaches an intermediate speed only, which is so proportioned that the car will go from floor to floor in a minimum of time.

At all times the car is under the control of the operator. If it is desired to reverse the car's motion at any time, the operator can do so by moving the car switch to a position corresponding to the desired direction. The inductor control may be cut out by a switch in the car and the machine operated at any desired speed from the car switch.

In the 60 Broad Street Building there are three elevators operating at about 700 ft. per minute, serving the equivalent of 22 floors of about 3,200 sq.ft. of rentable space per floor, which are occupied by tenants doing a brokerage business. These elevators are handling about 8,000 passengers a day and are maintaining a schedule on about 45 to 50 sec. headway. During the peak periods about 900 up passengers per hour are transported. When all the floors are rented, it is expected that over 9,000 passengers will be transported daily.

On account of the high speed it is difficult for the operator to read the numbers on the floors and also to

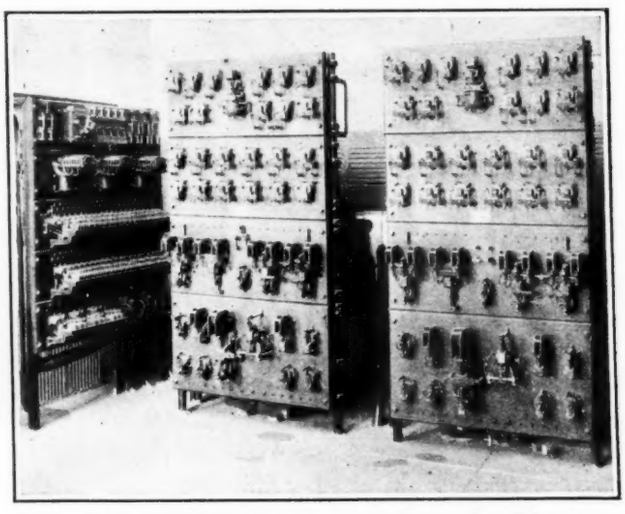

Fig. 6—Two elevator control panels with signal control on the left

make good landings without losing time due to unnecessary slowing down the car when preparing to make a landing stop. To overcome this difficulty the control is arranged so that the operator stops the car on signals and does not have to pay any attention to floor numbers. This has been done by placing in the car a bank of pre-register push buttons corresponding to the floor num-

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bers, also a car operator's flash, as shown in the upper part of Fig. 4.

When the passengers come into the car and call out their floor numbers, the operator presses the buttons corresponding to these floors. Pressing the button in the car closes a contact in the signal system, just as when one of the floor buttons is pressed. When the car is started by the operator, the car switch is held in the full on position until a signal bell and flash is received, at which time the switch is centered and the car goes to and stops automatically at the floor from which the flash and signal were initiated. This signal may be given either by the operator in the car or by a waiting passenger on a floor.

The signal system, which was furnished by the Elevator Supplies Company, contains a bank of mercury contacts, shown at the left in Fig. 6, for the floor buttons. There are no mercury contacts for the preregister buttons in the car, since these are of the type that lock closed when they are pushed. The floor signal system has the usual automatic reset machine, an operator's flash machine and a floor-lantern machine, all combined in a single unit. On the car signal system there is an operator's flash machine only The car signal preregister buttons are automatically released when the car approaches the terminal landings, by a magnet located below the push-button bank. The same buttons are used for either direction.

Fig. 7—Motor-generator sets for elevator machines and signal system

Back of one of the white glass disks above the preregister push-button bank, Fig. 4, there are two red lamps. Behind the other white disk are two green lights. The red lamps flash to warn the operator when the car is within 25 ft. of a floor from which a signal has been given for the direction in which the car is traveling. One of these lamps is for signals set by the operator on the preregister buttons, and the other is for signal given by waiting passengers at the landings. When the operator gets the flash, he has about 11 ft. travel in which to center the car switch before coming into the slowdown and stopping zone. At 700 ft. per minute this zone is about 15 ft. long.

The green lights operate to warn the operator that stops are to be made at successive floors. One of them is for the preregister signals in the car and the other for the landing signals. If the car was stopped at the third floor going up and there was a signal in the system to stop at the fourth floor, a green light would indicate this to the operator. Then, when starting the car, the operator would move the car switch to the first on position and as soon as the car started, the switch would be brought to the neutral position. The car would then go to the next floor and stop automatically.

The signal system is also arranged so that if the car does not stop at a floor from which a signal has been given, such as might be the case if it had a full load of passengers, the signal will be automatically transferred to the next car following.

At any time the operator may reset the preregister buttons by pulling lever *B* to the down position. For example, if, after making part of a trip, it is decided to return to the bottom landing, the preregister buttons can be reset by throwing lever *B* to the down position and then releasing it. The operator can then set the signals in the down motion just the same as when a complete up trip is made. This reset lever is also used should the operator push a wrong button. First, the buttons are released and then the correct ones are pushed.

Switch *A* is the electric control for the signal system. In case the car goes by a floor and the operator wishes to return to that floor, this can be done without disturbing any of the signals, by throwing switch *A* to the up position. Switch *C* allows the operator to stop and start the motor-generator set that supplies power to the elevator motor. At *D* is the short-circuit switch for the car-gate interlock. When the car is being inspected or repaired, by closing switch *D* it can be moved with the gate open. With the center switch *E* in the down position the machine is operated on automatic control. When this switch is in the up position, the machine is on car-switch control only. On the control panel is a double-throw multipole switch, by which the automatic part of the control may be cut out entirely and the elevator operated from the car switch, while repairs or adjustments are made on the automatic equipment.

On this installation the landing doors are not interlocked with the control. They are arranged to be opened by hand and close automatically when released by the operator. The car gate is interlocked with the controller, and the car cannot be started unless the gate has been closed first.

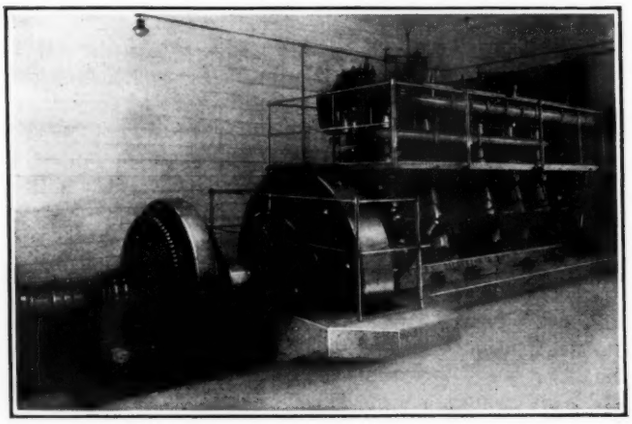
The author acknowledges with thanks the assistance rendered in the preparation of this article by R. F. Moon, vice-president, Atlantic Elevator Company, 120 Broadway, New York City, and to W. S. Westervelt, engineer, 60 Broad Street Building, New York City.

INTERNAL COMBUSTION ENGINES

Hints for Inventors of Fuel-Injection Systems

By P. H. SCHWEITZER*

Outline of Requirements—Limitations of Mechanical Parts—Necessity of Co-ordination of Entire Fuel-Handling System



NO PART of the oil engine has received more attention than the fuel-injection system, and extended efforts have been made to find the most satisfactory system for introducing the fuel oil into an engine. As a result we have almost as many types of injection as we have makes of engines, and are as far as ever from a standard system the superiority of which would be generally accepted, as is the carburetor for gasoline engines. Each of the various commercially developed systems has merits that are well emphasized by the maker and certain demerits that are ignored and frequently not even realized. Inventors, in laying out new and supposedly superior fuel-injection systems, frequently fail to realize the multitude of the existing problems. Their proposition, while superior in one aspect, may lag behind in others. There are many patents that offer satisfactory solutions respecting certain characteristics, but the idea is inapplicable without affecting adversely other characteristics. *And no chain is stronger than its weakest link.*

WHAT THE INJECTION SYSTEM CONSISTS OF

The injection system of an oil engine consists of mechanical parts for introducing the fuel into the cylinder or, more specifically, delivering it from the fuel tank to the combustion chamber. It generally includes a fuel pump, a fuel line and a spray nozzle. It has long been recognized that the interaction of these elements is so close that in dealing with them they have to be considered together rather than in separate units. Many a failure has been encountered by attempting to assemble an injection system out of proved elements such as a good fuel pump, a good fuel line and a good spray nozzle, without paying proper attention to the interrelation of these elements.

It is also well known that the design of the combustion chamber is related to the injection. The shape of the spray should fit the combustion chamber so the oil can come in contact with all the air possible, but at the same time avoid precipitation on the cold wall. Turbulence of the air always assists the atomization of the spray. The influence of necks, precombustion chambers and various means of controlling turbulence is well known. The shape of the combustion chamber largely determines the selection of the spray that will give the desired results in the engine. The duty of the injection system is to produce that spray and do it satisfactorily under various conditions.

THE DESIGNER'S LIMITATIONS

In laying out an engine, the designer always has something in mind with regard to the conditions under which the engine is to operate. He considers a certain speed, a certain load, a certain type of fuel, and he also expects the engine to be in perfect mechanical condition when running. There is a great probability, however, that the engine in the hands of the user will run at a different speed and carry a different load. Furthermore, the same engine will have to run under various speeds and loads at various times and burn various fuels. Still the engine has to perform its duty, and no injection system can be considered satisfactory unless it operates satisfactorily under all conditions encountered during service.

Certain factors affect the injection system more than others, causing troubles that are frequently unexpected. In laying out or judging a particular system, the variables to receive consideration are: Speed; load; fuel; clogging, or scouring, and leakage, due to poor condition of valve seats, connections, pump plungers and needle valves.

The variation of speed can be disregarded in the constant-speed engines; that is, in engines used to drive

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power generators, and most stationary machinery. In many applications a certain speed variation is essential. The engine speed generally affects the action of the injection system considerably. An injection system that may work satisfactorily in a power generating engine, might be entirely unsatisfactory in a marine engine.

An engine should be expected to operate under variable load conditions, and an injection system is not to be considered satisfactory unless it is able to operate satisfactorily under various engine loads.

Influence of Fuel Characteristics

Fuels having nearly identical heating values differ considerably in gravity, viscosity, surface tension and contained solid matter. Even the same fuel changes its viscosity and other properties with the temperature. It is a general requirement that the injection system should operate satisfactorily with a wide range of fuels.

There is always a possibility that fuel passages such as portholes and valves will get clogged during operation. The clogging is often caused by impurities in the fuel or metallic particles loosened from the injection mechanism. If a slight reduction in area of fuel passages causes serious disturbance in the operation of the injection system, such a system should be considered inferior. The system should operate at least tolerably if some of the passages are partly clogged. A removal of clogging material necessitates the stopping of the engine. Engines for application where stopping of the engine is undesirable, as in case of aëro-engines, must be least sensitive to obstructions in the fuel systems, including the pump, piping and spray orifices.

The enlargement of portholes by erosion is frequently caused by the fuel passing at high velocity. Systems that are less sensitive to clogging are less sensitive to scouring, as a rule.

Good valve seats and good fits of the plungers, valve needles and other injection mechanism parts are always important, but perfection cannot be attained and deterioration is always to be expected. Certain injection systems are less affected by imperfect seating than others. Erratic pump action due to air in the line and leakage of fuel are well-known troubles. Since wear and imperfections in metallic fits can never be entirely eliminated, it should be termed a general requirement of injection systems that the effect of leakage on the operation shall be as small as possible.

A fuel-injection system is required to deliver definite amounts of liquid in sufficiently divided sprays of suitable geometrical shape into a number of cylinders, accurately timed in relation to the engine cycle. Accordingly, each injection system consists of elements for performing each of these operations: Transporting; metering; timing; injecting and spraying.

Transporting is the delivery of the fuel to the spray nozzle. Metering is the measuring out of definite amounts of fuel for introduction into the cylinders with each cycle. Timing is the regulation of the time of injection in relation to the engine cycle. Injecting is imparting velocity to the fuel to carry it through the spray nozzle and to break it up into sufficiently small particles. Spraying is the formation of a spray fit to burn.

The sequence of these operations may vary, and frequently two or more of them are combined and performed by the same mechanism. However, an injection system can be considered satisfactory only if each of these functions is performed satisfactorily. The requirements concerning each of these five operations are distinct and independent.

It is not considered sufficient if an injection system is satisfactory just for one set of operating conditions. For different load and speed conditions and for different fuels, etc., the requirements regarding transporting, metering, timing, injection and spraying are unlike. For instance, for heavier loads an increase in the amount of metered fuel is necessary; for higher speeds earlier injection is desirable. In order to obtain best results each function should always be so adjusted as to fit best the actual operating conditions. Adjustability is the ability of the injection system to become adapted to various operating conditions.

It is the highest degree of adjustability if the respective operation is self-adjusting. The adjustment of the metering to the load is self-adjusting in governor-regulated engines. The adjustment that can be made without disassembling or changing of parts—for instance, by turning a handwheel or a nut—is generally preferable to adjustments that involve disassembling or changing of parts, even though the engine has to be stopped to make the adjustment.

Effect of Engine Speed

The change of operating conditions frequently affects various functions that should not be affected. For instance, decrease in speed results in a decrease of injection pressure in many injection systems. Stability or insensitivity is the ability of the injection systems to remain unaffected by the change of operating conditions where the effect is undesirable.

Not until a fuel-injection system performs satisfactorily the five duties listed and possesses a necessary amount of adjustability and stability, can it be considered a good injection system. Of course it may still be poor because of its poor mechanical construction. But if a system sins against the fundamental principles, it has deficiencies no mechanical perfection can correct.

Piston-Pin Seizing in Oil Engines is at times in evidence when turning the engine over at the beginning of a run. If, at the close of the last run, the cooling water was shut off too early, the heat in the piston head may evaporate all the lubricant on the piston pin. The dry bearing absorbs the heat, but it cannot expand outward because of the greater mass of the connecting rod end. The bearing closes in on the pin, which is also expanding; this action results in a gripping of the pin that is not completely loosened even after the parts have cooled. On starting, this wedged bearing restrains the motion of the connecting rod, and the engineer calls it a seized piston, though it actually is a case of a seized piston pin.

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Care of Connecting-Rod Bolts

By Edward Ingham, A. M. I. Mech. E.

THE nature of the material of which oil-engine connecting-rod bolts are made is a factor of fundamental importance. Generally, the bolts are either of wrought iron or mild steel. Some authorities recommend a high-class quality of soft wrought iron, such as "Low Moor" iron, on the ground that it is more reliable than mild steel. Mild steel may be rendered totally unsuitable by improper heat treatment, and some failures of steel bolts are to be attributed to a defective condition of the steel.

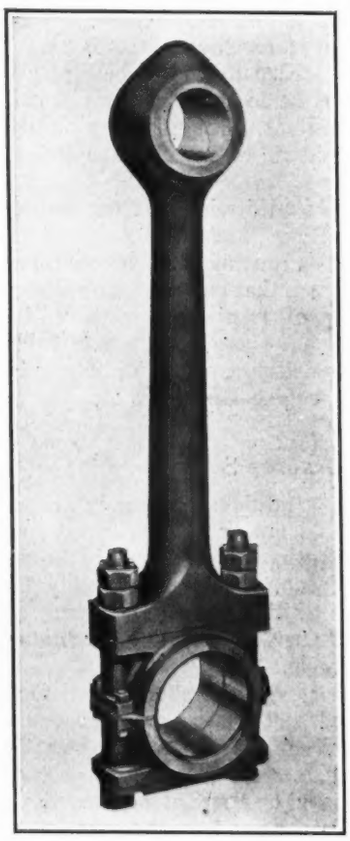

Fig. 1—A well designed arrangement of big-end bolts

Both iron and steel bolts are likely to undergo a change of structure in the course of time, and for this reason it is advisable to renew them at intervals not exceeding three years.

The practice of annealing the bolts with a view to restoring the material to its original state is not recommended, since, unless the annealing is very carefully performed, it may do far more harm than good. There are records where bolts have failed shortly after having been annealed, a fact which would seem to show that the annealing has had deleterious effects.

Many users consider that to anneal their bolts merely necessitates heating the bolts to a high temperature, for a fairly long period, and then allowing them to cool. Such crude treatment is likely to be attended with serious consequences. In most cases the heating is done at too high a temperature and is unduly prolonged. The cooling also is generally done in an unsatisfactory manner.

The temperature should not exceed about 1,100 deg. F., and the bolt should be heated until it is at a uniform temperature throughout, after which it should be cooled uniformly and slowly. Sudden cooling, such as would be occasioned by placing the hot bolt on a cold floor, must be particularly avoided.

For really satisfactory annealing it is necessary to know the chemical composition of the bolt material and to possess a knowledge of the heat treatment of steel. As the user is not as a rule possessed of this knowledge, he should not entertain the idea of annealing, but rather should replace the bolts by new ones from the makers after they have been in service about two years or at the most three years.

The design of a connecting-rod bolt is not such a simple matter as it is sometimes supposed to be. There are a number of factors that require consideration if the bolt is to prove safe in working.

The first consideration is, of course, the diameter of the bolt.

A fault of the past was to make the bolt too small. There was a widespread notion that because the pressure

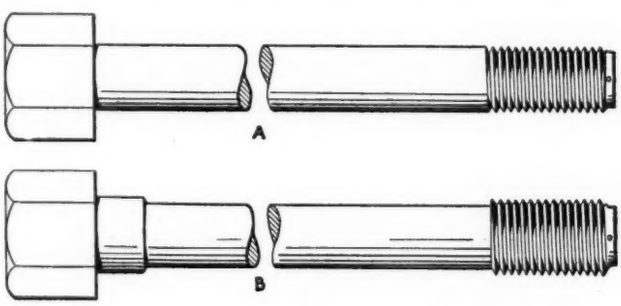

Fig. 2—Rod bolts should be reduced at the shank

acts only on one side of the piston, the connecting rod is always in compression, so that the only stress on the bolts is that due to tightening up. This, however, was a serious mistake, and bolts are now made heavier.

The working stress which should be adopted is a most important consideration. For several reasons it is desirable to allow a good factor of safety; that is, to adopt a low working stress.

It is unlikely that each bolt will take just half of the total accelerating force, so that one bolt is likely to be called upon to bear more than the load for which it is designed. Again, the load is not applied very gradually, but more in the form of a live load, and, as is well known, the stresses imposed by live loads are far greater than those imposed by gradually applied loads of the same amount. Further, the piston is not by any means frictionless, and whatever friction there may be adds to the load on the bolts.

Under the circumstances a factor of safety of not less than ten should be adopted, which means for bolts made

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of wrought iron having a tensile strength of say twenty tons per square inch, a working stress of two tons per square inch.

When the size of the bolts has been determined, the actual design needs careful consideration. For the greater part of its length the bolt should be turned down to a diameter equal to the diameter at the bottom of the thread as shown at *B* in Fig. 2. This procedure, by preventing localization of stress about the threaded part, greatly reduces the risk of fracture. Sharp fillets or square corners at parts where there is a change of diam-

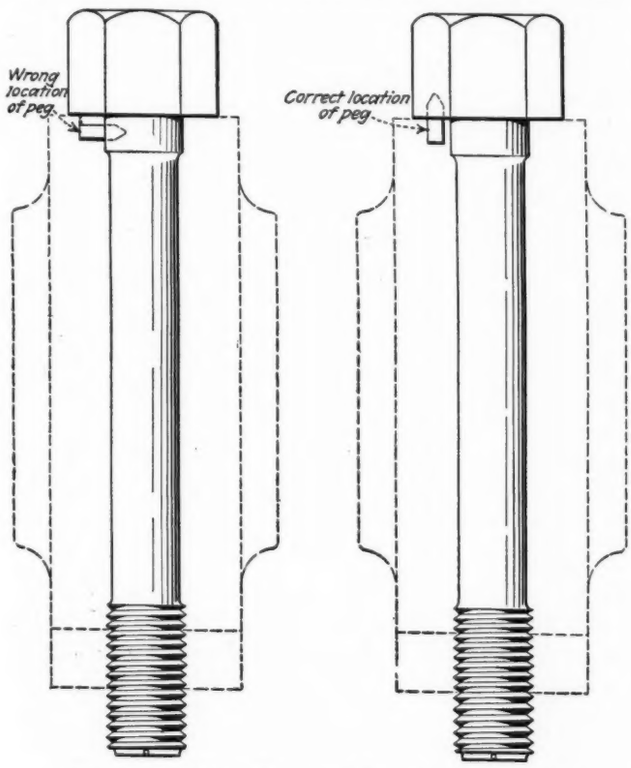


Fig. 3—Right and wrong place to place the peg

eter should be particularly avoided, as there is a tendency for fractures to develop at sharp internal corners.

A matter of the greatest importance is to avoid finishing the thread abruptly in the full diameter of the shank. A turned-down portion should be arranged at the finish of the thread, so that the cutting tool or the dies will run out at the reduced part and not leave an abrupt finish.

Another matter, apparently trivial, yet of considerable importance, is the manner of fitting the peg used for preventing the bolt from turning when the nuts are tightened up. This is commonly fitted into the shank of the bolt just under the head as shown at the left in Fig. 2. The effect is to reduce the sectional area of the bolt, and the fact that failures have occurred through fractures developing at peg holes so located, shows the advisability of fitting the peg into the head of the bolt instead of into the shank. This is illustrated at the right in Fig. 3.

When bolts are designed and made in the manner herein outlined, they are not likely to fail under satisfactory working conditions. It is important, however, that the engine user should take care that the conditions of working are maintained satisfactorily. Bolts of ample strength and well designed in every respect, have failed in the past, and such failures must be attributed to undue stresses having been thrown upon the bolts owing to some fault in the working of the engine.

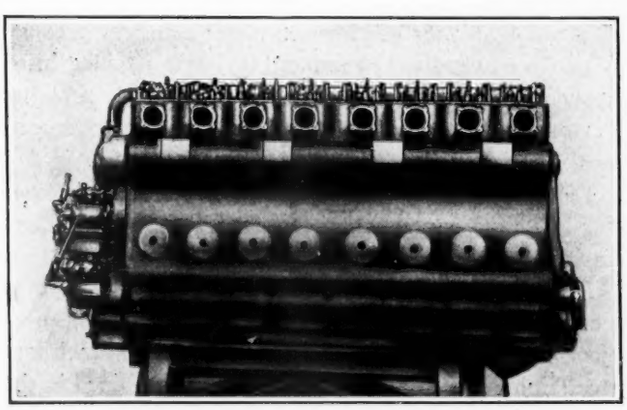
Another matter that requires every attention is the adjustment of the connecting-rod bearings. The two brasses of the crankpin bearings must be closed up against each other with sufficient force to prevent any movement. The slightest slackness, either of the brasses or the bolts themselves, will result in heavy knocking, which if allowed to persist, will lead to breakdown.

After a certain length of time wear of the brasses will take place, and it will be necessary to take up this wear, either by removing a liner, if such are fitted, or else by filing the brasses. The latter operation requires a skilled man, and should not as a rule be left to an attendant who is not a qualified mechanic, since imperfect fitting may ultimately be attended with serious consequences.

A number of bolt failures have occurred through severely stressing the bolts when tightening up. Where large bolts are concerned, the stress due to tightening up is not usually important, but with small bolts, injudicious tightening may easily set up dangerous stresses. Some attendants show utter recklessness in tightening up small bolts, and for this reason, no matter how small may be the engine, it is advisable to use bolts of ample diameter.

English High-Speed Diesel

THE illustration shows the high-speed Diesel developed by Wm. Beardmore & Co., England, for airship service. This engine has eight cylinders of 8.5-in. bore and 12-in. stroke. It is designed to run at 1,000 r.p.m. for a normal output of 650 b.hp. and weighs 3,000 lb. Engines of this design are built in capacities ranging from 100 to 1,500 horsepower.



The 650-hp. Beardmore Diesel

EDITORIALS

Let the Machine Do It

IT HAPPENED this way. The "one hundred per-centers" feared an overload on the post-war American melting pot with resulting confusion of tongues and ideals. Labor dreaded the cutthroat competition of European immigrants. So the walls went up despite the misgivings and protests of manufacturers who could see nothing but mounting production costs with cheap labor cut off at its source.

And then a strange thing happened—people began to think. Long-pigeonholed suggestions for replacing human hands by steel and iron and the muscles driving them by electrical and mechanical power were tried out. New appliances were perfected in ever-increasing number. Machines multiplied enormously. Men sweated less but drew more pay because they produced more. And, strangest of all, the products of high-priced labor were sold abroad in competition with those of alien labor working for a pittance.

Thanks to necessity, the lesson has been learned that no labor is cheap, however low the hourly wage. As a result every nook and corner of industry is being mechanized. For years machines have cut, ground and rolled. Now they lift, carry, clean, measure, count and regulate. And men are more and more freed for their real job, which is thinking.

Refinements of Over-Fire Injection

OVER-FIRE air injection has long been recognized as a means of preventing stratification of furnace gases and an effective weapon in combating smoke. In fact, it is being prescribed by many city smoke inspection departments.

Whether this air be blown in under sufficient pressure to produce turbulence or induced by steam jets that bring about the desired mixing, appears to be largely a matter of individual preference governed to some extent by local conditions.

Data are available showing the results of such over-fire injection, expressed in terms of better combustion, improved efficiency and less smoke.

In many cases, however, the remedy is applied in a more or less hit-and-miss manner. The desired improvement is brought about and the efforts stop there, without ascertaining whether the results are being attained in the most efficient manner. Heretofore, practical information that would aid the average engineer on this score has been lacking, and it is therefore helpful to have available the experience of the Smoke Department of Cleveland as expressed by Mr. Kugel in this issue.

The tests quoted indicated that the size and shape of the induction tube and the distance of the nozzle from the tube have considerable bearing on the results. Also, they demonstrated that the usual practice of inserting the jet inside the induction tube is poor and that best results are had with the jet about one tube diameter from the tube. There is apparently much to be learned about this simple expedient.

Modern Sales Methods in the Central-Station Field

IN THE past the engineers of industrial power plants have too often felt justified in criticizing some of the applications of central-station power to industrial needs. They have felt, and perhaps with some reason, that often the industrial power consumer was sold with too little regard for actual needs and that often he could have realized more economy from generating all or part of his power requirements in his own plant.

Of course this situation, which undoubtedly did exist at one time, has mostly passed. The instances that are criticized now are mostly cases where neither the central station nor the prospective customer knew what the needs of the case really demanded. The utility is as well aware as anyone else that a customer, to remain a customer, must receive real benefits from his purchases of central-station products. Lack of knowledge of what was actually the most economical procedure in some cases, must take the blame for uneconomical installations.

It is, therefore, of interest to note the new sales method being adopted by some public utility companies. They are subjecting the districts which they serve to intensive study, carried out by unprejudiced industrial engineers. In this way the most economical power installation for each industrial plant in their territory is determined, be it all central-station service, isolated-plant service or a combination of the two. Selling is carried out on the basis of the findings of this study. As a consequence central-station current is sold only to those industrial customers who can profit from its use. Power engineers of such districts become advocates for central stations instead of detractors, and the whole community benefits. Here is another example of the benefits that flow from modern, scientific, fair sales methods, which can be realized in the sale of power as well as in the sale of cabbages or shoes.

Don't Forget Production!

MANUFACTURING plants have just one excuse for existence—*production,* measured in quantity, quality and cost. Every machine, every service and every man must serve this end or face inquisition by the first competent management that arrives on the scene.

Nor is this fact so depressing as it may seem at first. The immediate motive that leads management to judge solely by the ultimate result may or may not be purely selfish, but the net effect is definitely beneficial to humanity at large. No proof of this statement is needed by those who have studied the causes of American prosperity. The occasional tragedies of the unfit, whether individuals, machines or organizations, are far outbalanced by the gain to all when production is entrusted only to the hands of the effective.

Engineering, which has been aptly defined as "science plus the dollar sign," can never afford to forget the two vertical lines on the capital S. It is a difficult rôle—the engineer's. He plays with tools whose mastery is in itself a deep satisfaction. Heat units, pressures, gears, pulleys and electric currents have a unique appeal to the type of mind that can understand them and unravel their infinite combinations. Right here lies the danger that the means may obscure the end, which is production and nothing else. "Will the contemplated change reduce the cost of the product or make it better?" is the eternal question of the real engineer. Without this test, diligently applied, engineering is but another form of parlor magic.

Making the Best of Circumstances

TWENTY years have seen great advances in power-plant equipment and operating methods, resulting in notable decreases in the cost of power-plant products. As a result, engineers who are faced with the necessity of operating industrial power plants built over twenty years ago and making these plants yield an economy satisfactory today, often feel discouraged. Unless they can induce their managements to scrap the old equipment and install the latest and most efficient designs, they often incline to give up the fight and let the central station have the business, even when they know that, with the proper facilities in their plants, the central station cannot serve as cheaply.

When engineers thus lose heart, they can acquire new courage to carry on by considering what others have done. For instance, one plant with twenty-nine-year-old boilers and Corliss engines of the same era, repaired and modernized these boilers, introducing powdered coal firing. As a result, one-half the boilers formerly used could carry an increased load, so that five boilers were scrapped. To improve the heat balance, a mixed-pressure turbine was added to the generator equipment. These changes, owing to savings made, quickly repaid their cost. And the plant, in spite of its old engines with their forty-pound water rate, is making a kilowatt-hour cheaper than it can be bought from the public utility which has the lowest rates in the United States, whose main stations are nearby.

This is undoubtedly an outstanding achievement and one that most industrial plants cannot equal because their conditions are not so favorable. It does show, however, that often a small expenditure for improvements in an old plant is thoroughly justified. Bringing examples such as this to the attention of the management, will help the engineer to bring his plant up to date and place it in the position where it accomplishes its original purpose—that of supplying power for industrial use at the lowest over-all cost in the finished product.

Modernization Need Not Be Expensive

FOLLOWING the example of Ulysses as he sailed by the siren, many plant owners stop their ears to the song of modernization. This bringing their power plant up to present-day standards costs money, so they think, and the old machinery is left to stagger along under new burdens.

True, a complete new power plant does cost money, but if the wherewithal is not handy, why not revamp the existing machines? Hundreds of engines are kept in service even though cylinders are worn and valves scored, when a small investment would give these engines all the economies of more modern units. Even at present many engines have been supplied with new cylinders of the uniflow type, with a consequent reduction in fuel consumption as much as seventy-five per cent. The cost in many cases does not exceed twenty-five per cent that of an entirely new unit.

The same procedure can be followed with old boilers. The increase in furnace volume by simply raising the boiler, will give a high return on the cost, through the resulting economy.

True, high-pressure steam offers an increased efficiency, but does not offer much greater return on the added investment than does the remodeling of older engines and boilers in cases where the management cannot afford to build a new modern plant.

"BY THE ADMIRABLE CONTRIVANCES of Watt and Fulton, the steam engine . . . has laid a sure foundation for all those future miracles of mechanic power which are to aid and reward the labor of after generations." Thus truly spoke the Reverend John Platts in 1821. What would he have said if he could have visioned the power services in the industrial plant of today?

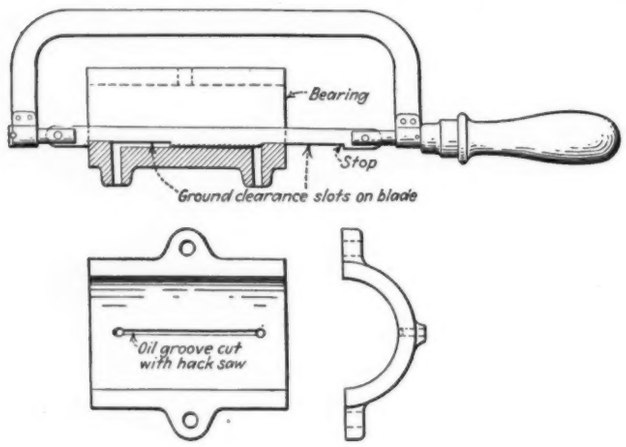
IDEAS *from* PRACTICAL MEN

Readers are urged to use this department for the exchange of practical operating information. A minimum of five dollars will be paid for contributions accepted

Sawing Oil Grooves in Babbitted Bearings

SOME time ago I tried out a new method of cutting oil grooves in babbitted bearings, and it occurred to me that it might be of value to other readers.

I took a couple of old power saw blades, clamped them together and ground clearance slots in them the proper depth and distance apart. With both blades mounted in a hacksaw frame, it was then a simple matter to saw the oil grooves in a number of bearings having an oil hole near each end.



How the oil grooves were cut

There is a certain knack in starting the cut, which experience will teach better than a column of description, but, briefly, it consists in cutting with the back teeth of the saw until the cut is fairly well started.

With a bearing having only one hole in the center, I chip or drill a small clearance hole at each end.

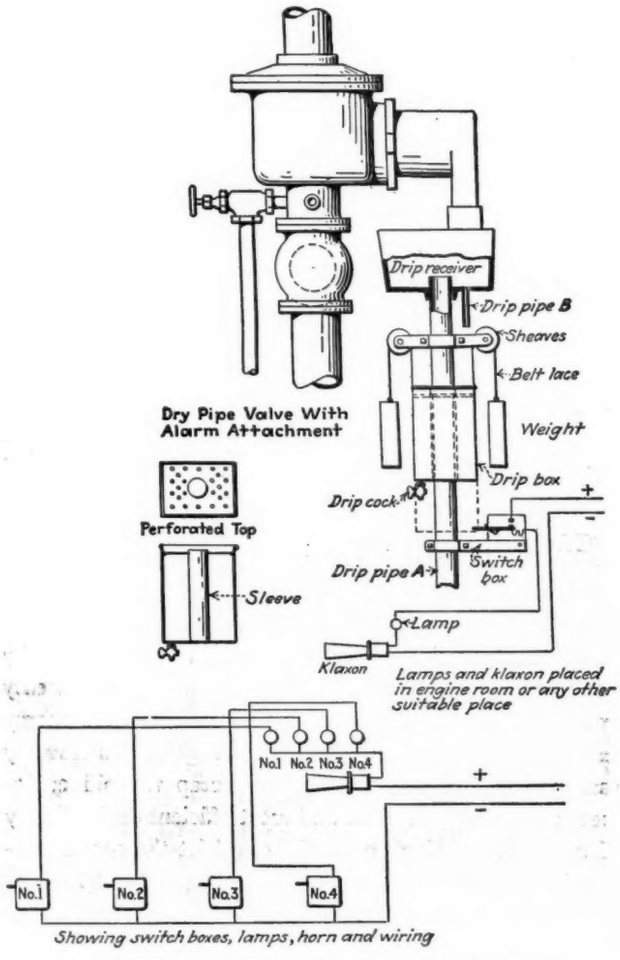
Hamilton, Ont., Canada. W. KENDALL.

Alarm Attachment for Dry-Pipe Valves on Automatic Sprinkler Systems

ANYONE familiar with automatic sprinkler equipment knows the trouble caused by dry pipe valves tripping, especially on systems exposed to low temperatures, such as cold-storage freezers that are usually piled up with frozen goods that must be moved before the piping can be taken down for thawing. Automatic sprinklers in general cause little trouble, but sometimes small air leaks occur that are hard to detect.

On slow air leaks the air pressure on the system gradually drops until a small amount of water leaks past the valve and into the drip receiver. If this leak continues, the valve will finally trip. The auxiliary alarm described herewith is designed to warn the attendant that a certain system needs immediate attention.

Drop pipe *A* should be galvanized and threaded so as to extend at least one-half inch above the bottom of the drip receiver as shown. A hole is drilled and tapped for $\frac{1}{4}$-in. pipe close to the pipe *A*, and a nipple *B* is screwed into this, as shown, the inner end being made flush with the bottom of the drip receiver. The drip box is made of light-gage galvanized iron or copper with top dropped about one inch and perforated. The bottom of the box is tight and fitted with a drain cock. Passing down



How Alarm Mechanism was Attached to Sprinkler Valve

through the center of box is a sleeve made so as to allow the box to slide freely down the drip pipe. A bracket clamped to pipe *A* carries the small sheaves over which the drip box and counterweights are suspended by two strips of belt lacing. The switch box is an ordinary condulet box fitted with a fiber lever and terminals for wiring, and clamped to the pipe *A* as shown.

The indicating lamps and klaxon horn are placed in the engine or boiler room, or any other suitable place, and wired up as shown. Each lamp is numbered to correspond with a certain dry pipe system.

When water starts leaking into the drip receiver, it passes through pipe *B* into the drip box. When enough has leaked into the box to raise the weights, the box slides down and closes the circuit, causing the klaxon to sound and the corresponding lamp to burn, the attendant knowing at once where to go. To reset the apparatus, the drip box is drained, which allows it to go back to the top position.

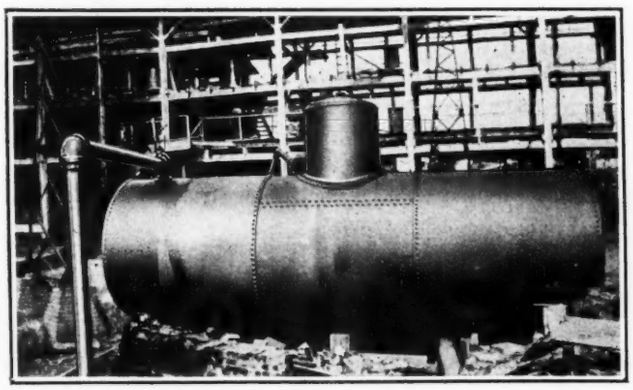
This apparatus has been in use in a large cold-storage plant for a number of years and has given entire satisfaction. A. GIGER.

Vancouver, B. C.

Fighting Fire with Air Forced Water

IT FREQUENTLY happens that industrial establishments are not located in access to elevated water tanks from which water can be had under gravity pressure for combating fires that break out in the plant. In many cases the capacity of the plant or the volume of business does not warrant the installation of a separate water tower. The illustration shows how this service was provided in one plant by using an old boiler for the water supply tank and compressed air to give the pressure.

The tank was placed at a convenient location at the plant for keeping it filled with water and the air and water connections were made at the top, and the header line for the hose connections to the bottom.



Old boiler used as water-storage tank

In one plant where this system was used, no regular air compressor was installed, but an old locomotive air-brake compressor was available, so this was overhauled and put into service. In plants where a large air compressor is already installed and a supply of compressed air is always available, the installation of this system is, of course, much simplified, and it should prove entirely satisfactory.

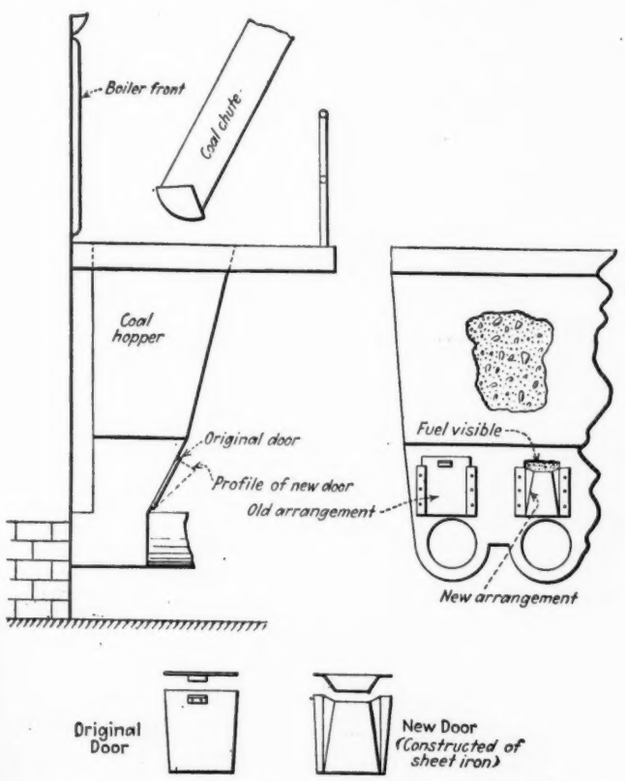
For best results a large air-storage tank or receiver should be used with this system, so that a supply of compressed air is always available. L. M. JORDAN.

Cairo, Ga.

Improvement to Stoker Hopper Permits Observation of Coal Feed

AN INNOVATION which may prove of interest to engineers operating the usual types of single- and multi-retort stokers is the observation door which we fitted to the stoker hoppers in a plant containing several underfeed stokers.

In this plant the system of coal handling was such that the coal larry operated from a mezzanine floor above the firing floor proper. The stoker hoppers were extended up to this floor, making it difficult to see whether the coal was sticking or arching over the rams. The hopper was fitted with a small door directly over the rams, but if this was opened a quantity of coal would fall to the floor and sometimes the door would stick and become difficult to remove.



Improved door in stoker hopper permits ready observation of coal feed

To overcome this and at the same time do away with the necessity of opening the door at all, we constructed a door as shown in the accompanying sketch. This not only gives a view of the coal in the hopper, but a piece of pipe can readily be inserted to break up any coal that arches over the rams. R. G. EDWARDS.

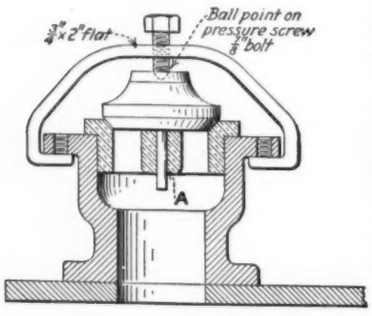
Port Arthur, Ont., Canada.

COMMENTS *from* READERS

Holding Safety Valve Shut While Applying Hydrostatic Pressure

IN THE Jan. 17 issue the screw and dead weight type clamps for holding safety valves while applying hydrostatic pressure were illustrated and described. A type of clamp that puts the pressure directly on the valve disk is shown in the illustration.

This is a simple method of holding the valve shut, but it has the advantage of giving complete examination of the valve and a check on the freedom of the guide spindle in the seat, as at *A*. It is important that the clearance on this guide spindle be checked from time to time, otherwise the valve may become sluggish in operation and not close properly without an excessive blowdown or drop in pressure.



Clamp applied directly to valve disk

A practice sometimes used and one that I think is a good one, especially where the boiler has only one safety valve, is the use of a small valve set a few pounds lighter than the main valve. This small valve serves to warn the operator and also saves considerable steam.

R. K. WALSH.

Port Au Port, Newfoundland.

* * * *

Where Does the Air Go?

THE pressure-volume conditions of perfect gases, like air, are easy to figure out, and every high-school graduate knows that pressure times volume is a constant if the temperature remains the same. It is likewise well established that in case of a liquid like water, which is practically incompressible, pressure increases directly with depth. But even with these laws well understood, it is possible to strike a condition that is extremely unsatisfactory.

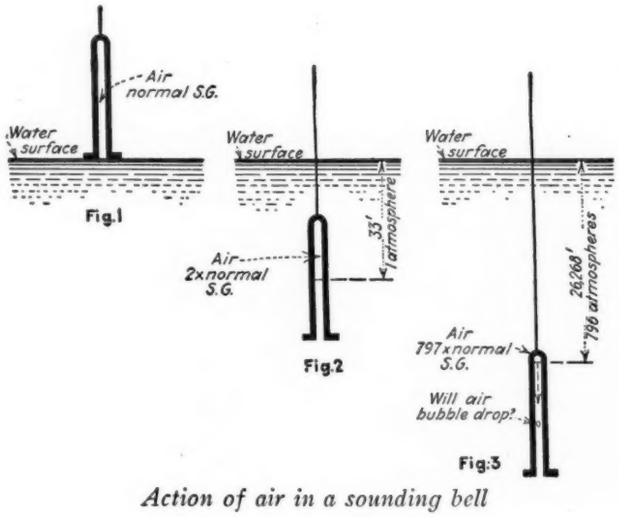
Let us consider a sounding lead, as shown in the illustration. This is a metallic body with a hollow center open at the bottom and so weighted that it will sink in an upright position. At the surface of the water a certain amount of air is trapped in the hollow core. At 39 deg. F. this air, under atmospheric pressure only, weighs 0.0807 lb. per cu.ft. The sea water into which our lead is to be submerged, weighs approximately 64.3 lb. per cu.ft., or very nearly 797 times as much.

If we submerge the sounding lead 33 ft. the water pressure will be $(33 \times 64.3) = 2{,}122$ lb. per sq.ft., which is 14.7 lb. per sq.in., or one atmosphere. This exposes the entrapped air to one atmosphere of air pressure, which is exerted on the surface of the water and one atmosphere of water pressure, making the total pressure twice what it was at the surface. The volume, according to the well-known law, will be one-half and the density double that at the start; consequently, the water will weigh only $\frac{797}{2} = 398.5$ times as much as the air for equal volumes. This condition is shown in Fig. 2.

Submerging another 33 ft. will make the air pressure three times normal when the water will be only 266 times the density of air. It is obvious that, as we sink the lead deeper and deeper, the specific gravity of the air approaches that of the water.

If we sink it to a point where the water pressure is 796 atmospheres, the volume will be $\frac{1}{797}$ of the initial and specific gravity will equal that of the water. The required depth will be $796 \times 33 = 26{,}268$ ft. If we submerge it still farther, the density of the air will exceed that of the water and an interesting field for speculation is presented, as shown in Fig. 3.

Will the air now heavier than the water, fall through the contained water and escape? When it gets to the bottom of the center core, will it rise to the surface in bubbles or will it continue to descend to the sea bottom, remaining there like drops of mercury in a glass of water?



Action of air in a sounding bell

Fortunately, the liquefaction of the air need not be considered, as the temperature is too great for that to take place regardless of the pressure. The most probable answer is that the air will be absorbed by the water, but that is really only a skillful evasion of the question,

and the writer would like to know what others think about it. ELMER S. SMAIL.

Chicago, Ill.

[The probable explanation is that the pressure-volume law does not hold even approximately true at high pressures, and the air density never equals the water density. Discussion by readers is invited.—Editor.]

* * * *

Grouting vs. Bedding Machinery

WITH reference to the article, "Grouting vs. Bedding Machinery," by J. Jordan in the Jan. 10 issue I, too, am a convert to that method of bedding machinery. In one plant with which I was connected, I had occasion to remove a small high-speed engine to make room for a larger unit. Upon moving this machine, we were surprised to find the grouting filled with pockets and discovered that a large portion of the bedplate surface had not been supported by the grouting at all.

In setting the large unit, we used equal parts of washed sand and portland cement mixed with a small amount of water. This was packed or forced into the space between the foundation and the bedplates, and after 24 hours was allowed for it to harden, the foundation bolts were tightened permanently. It gave us a good firm bearing surface, and this unit has operated satisfactorily for several years. I have since used this method in setting a large cross-compound Corliss engine with the same results. I feel certain that this way of bedding heavy machinery is far superior to the usual grouting method.

Fairmount, Minn. E. R. WEBBER.

* * * *

Imagine the Savings!

IN LOOKING through a recent issue of *Power,* I noted the editorial entitled "Imagine the Savings!" It has been my experience that the man who uses steam in a process is not at all fussy as to whether he uses one dollar's worth or five. Also, from direct contact with men of this type and also flow meters, I still find the same conditions prevail. If the man in charge wishes the flow meter to pay for itself, he must personally look after the efficiency of the various processes and teach the operator how to save steam.

I know of one plant where thousands of gallons of water must be heated, and every degree rise in temperature represents approximately 50 cents an hour.

As the plant operates 24 hours a day, a difference of ten degrees in temperature means over $100 a day. The operatives will not try to use less water—they will not try to drop the temperature, but the man in charge of the power plant has absolutely cut the amount of water passed by the pump and the temperature several degrees, so that the saving in that particular department runs into thousands of dollars a year.

Flow meters are a mighty good investment if they are taken seriously, kept in proper condition, and their readings broadcast in the right direction.

I have in mind an installation of twelve or fourteen flow meters which probably cost $7,000, and the engineer says they paid for themselves the first year.

In the case of heating water the man in charge of the steam plant could have slowed the pump and reduced the temperature slightly and thereby made a big saving, but who would believe him? But with the flow-meter on the steam line to this particular apparatus and a graphic chart to tell its story, he had the proof of the pudding.

I should like to say just a word in regard to heating and ventilating. It is not always a waste to have window leakage. Perhaps the coal pile will suffer to some extent, but in factories where large numbers of operatives are employed, the fresh air, even though it requires more heat, will make a bigger production possible.

This fact was pointed out to me by the president of a large company more than 25 years ago. A blower system was used, and it was possible by proper manipulation of tower and basement doors to recirculate a large portion of the air and thereby save a couple of tons of coal a day.

He said: "You poison the air and save eleven dollars a day in fuel. Give 'em lots of fresh air and you raise the production 10 per cent." By window leakage I don't mean broken panes or cracks half an inch wide, but the slight leakage that factory windows usually have.

New York City. C. W. PETERS.

* * * *

What Makes Boilers Drum?

I HAVE been interested in the discussion going on in *Power* with regard to boiler's drumming. Unfortunately, the type of boiler on which the drumming occurred is not mentioned in each case. In the case of return-tubular boilers the reason they drum is because some gases do not ignite until getting into the flues. A pyrometer put in the chamber after the gases leave the boiler will show a certain temperature when the drumming occurs. Then, if the drafts are changed to slow the gases to reduce the temperature, the gases are completely consumed in the furnace before entering the flues, and the drumming ceases.

All the devices for eliminating drumming have probably cured the trouble, but have not explained the real cause. A. A. LINDLEY.

Spokane, Wash.

HAVING had experience with a horizontal water-tube boiler which drummed when burning bituminous coal on a natural-draft chain-grate stoker, it is my opinion that the drumming is due to the following causes:

The fire becomes slightly coked over and allows only sufficient air for the production of CO. This condition causes an increase in pressure difference through the fire bed to the point where the air will suddenly rush through. This burst of air relieves the pressure difference momentarily. The pressure difference then again increases, causes more CO to be formed, until another burst of air comes through, causing another combination of O with CO, and the relief of the pressure difference again. These occurrences are really minute explosions and occur so rapidly as to cause violent vibration of the whole boiler.

Although the vibrations may be more noticeable at the breeching, it is believed that the explosions occur immediately over the fire, since the gases are not hot enough for the combination of O with CO very far from the fire.

The fact that opening a door, changing the damper setting or poking the fire with a bar, stops the "drumming," seems to bear out this theory.

If it were possible to make flue-gas analyses fast enough, from a position over the fire, then proof of this statement could be offered. H. F. PURTEE.

Kansas City, Mo.

Sizing of Coal

I WAS much interested in the article by G. B. Mulloy in the Nov. 8 issue of *Power*, and in addition I would like to have his opinion on sizes of coal for forced-draft chain grates expressed in general terms. For instance, can he agree with the statement to the effect that all coal that goes over a 1½-in. screen adds nothing to the efficiency of combustion and that coal that goes through a ¼-in. screen should be reduced as low as 20 per cent, if this were possible, and that the remaining 80 per cent should be divided equally in the various sizes of from over 1-in. down to ¼ in.? I presume that the tests were on forced-draft chain grates. It would be of advantage to know the percentage of ash in the coal as fired and the origin of the coal. I should also like to know the make of the stoker used.

For a long time I have felt that considerable improvement in blast chain grates could be effected through suitable sizing of the coal. Since he has definite data on this matter, some further general remarks would be appreciated. Were water-cooled walls used to any extent, and if not, what provisions were made to avoid clinker troubles at the side walls? S. R. LYON.

St. Louis, Mo.

THE tests were conducted on natural-draft Green chain grates. The fuel used was Southern Illinois coal obtained from Franklin County. For the furnace referred to there were no air or water-cooled side walls, the construction being the standard, solid brick walls used in common practice four or five years ago.

Relative to the inquiry concerning sizing of coal, I do not believe that coal staying on a 1½-in. screen adds anything to good combustion, as from experience it has been found that ashpit loss mounts up rapidly when there is an appreciable percentage of coal large enough to stay on a 1½-in. round-hole screen. It is reasonable to suppose that for a given speed of grate, it will be impossible to manipulate the draft, whether forced or natural, to burn out the larger pieces of coal in the same length of time required to burn the more evenly sized coal.

Starting with coal over 1-in. and going down to over ¼-in., the table in the article shows that these sizes amount to a total of about 62 per cent, while the amount going through the ¼-in. screen approximates 35 per cent. As this mixture gave good results on the natural-draft plant referred to and also on a forced-draft Cox traveling chain-grate installation, the experiments were carried no farther, as it was possible to develop with this sizing of coal a rating of 150 to 200 per cent on both plants and keep low the percentage of carbon in the ashpit.

There is another element that might enter into this problem, although I have not gone into it far enough to make a statement, and that is, the coking and clinkering qualities of the coal may govern how far it will be possible to go with the sizing.

One thing definite is that, whatever sizing you elect to operate on, if you have a good crusher that will give you continuously the same sizing every day, you will be able to obtain uniform results in CO_2, uptake temperature, ashpit loss, etc., and if the draft is sufficient, you can set the crusher to burn a greater percentage of the smaller sizes, if so desired. G. B. MULLOY.

Chicago, Ill

Answers to What Do You Know

The questions are on page 632

Ans. 1—The rush of air will create a rarefied condition in the pipe and the pressure will drop below atmospheric; successive periods of compression and rarefaction will occur until the pressure gradually reaches a permanent value equal to that of the atmosphere.

Ans. 2—Rape oil is used in the manufacture of marine-engine lubricating oil, being mixed with mineral oil.

Ans. 3—If there is no large receiver at the engine, the velocity should not exceed 6,000 ft. per min.; the use of a suitable receiver permits velocities up to 10,000 ft. per minute.

Ans. 4—In the reciprocating compressor the jackets and intercoolers remove much of the work of compression, but there is practically no cooling in a turbo-compressor and the heat equivalent of the compression work remains in the air; in addition, the surface friction of the turbo blades adds heat to the air, which causes the compression line to be steeper that the adiabatic.

Ans. 5—Several mines are equipped with oil engines, and the mine owners state that the reduction in labor and night-banking charges makes the arrangement economical.

Ans. 6—Lord Kelvin suggested that it was possible to heat a house by a refrigerating machine. The process embraces the evaporation of the refrigerant by the absorption of heat from the cold atmosphere, its compression and its condensation at a higher pressure by the transfer of its heat at a high temperature to the air entering the house.

Ans. 7—The term clearance is used in two senses. It may refer to the distance the piston can be separately moved beyond its position at the end of the stroke before it comes in contact with the head of the cylinder, or the term may be used with reference to the volume of space in the end of the cylinder and connected passages from the piston to the valves, when the piston is at the end of its stroke. To avoid confusion, the former is called "piston clearance" and is always a lineal measurement, and the latter is termed simply "clearance," and the amount generally is quoted as a percentage of the volume swept through by one stroke of the piston.

Ans. 8—If a fan is driven by a series motor, the speed of the motor may be varied by connecting a resistance in parallel with the field winding. If the motor is of a shunt type, its speed may be varied by connecting a resistance in series with the field winding. The value of the resistance will depend upon how much the speed is increased and upon the size of the motor. It is doubtful if a motor that had been designed to drive a fan of a given size, can have its speed increased very much without being overloaded, since a fan load increases as the cube of the speed.

Ans. 9—When the wristplate is in mid-position, the steam valve must have negative lap; that is, it must be part way open.

Ans. 10—The formula to use is

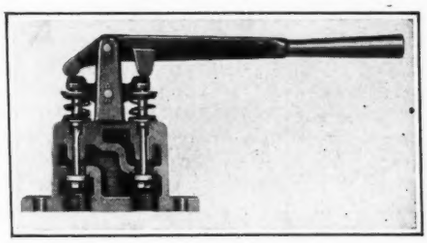
$$Sp.\ gr = \frac{140}{130 + deg.\ Bé.}$$

New and Improved EQUIPMENT

Ross Operating Valve for Single- and Double-Acting Cylinders

OPERATING valves of the three- and four-way types for the control of single- and double-acting air cylinders have been brought out by the Ross Operating Valve Company, 6488 Epworth Blvd., Detroit, Mich.

The poppet principle with the air pressure against the poppet is one feature of the design. All the ports are on one face, so that the valve can be mounted on a plate to which the piping



Section of operating valve

is attached. This construction makes the piping a permanent installation, and the valve can be readily removed without disturbing it.

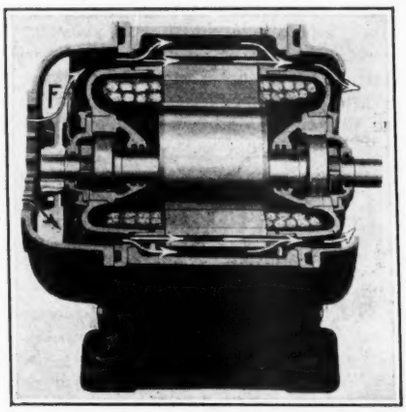
The valve design includes a flexible seat, and this obviates the necessity for lapping or grinding when servicing is required. The valve is made in two styles, 5-P for double-acting cylinders and 3-P for single-acting cylinders. Both styles are made in four sizes, $\frac{1}{8}$-, $\frac{1}{2}$, $\frac{3}{4}$- and $1\frac{1}{4}$-inch.

New Totally Inclosed Ventilated Motor

A NEW completely inclosed ventilated ball-bearing motor with a 40-deg. rating has been developed by the American Electric Motor Company, Cedarsburg, Wis. As shown in the figure, the windings are totally inclosed. Cooling of this motor is obtained with an external fan *F* which causes air to flow over the end bell and the stator laminations, as indicated by the arrows. The stator core is perforated, thereby making it possible to remove the heat at the point where it originates. The inclosing hoods of the motor can be removed without disturbing the bearings.

Should the stator winding be damaged, the core and its windings can be easily removed for repair. The ends of the windings are taped well within the slot to avoid the possibility of breakdowns between the wire and the end of the slot insulation. After the stator s wound, it is dried in an electric oven until all moisture is evaporated. It is then dipped in an oil- and acid-proof varnish. This process is repeated four times.

An unusual test demonstrated how effectively dust is excluded from the



Fan F provides ventilating air around the stator frame and core

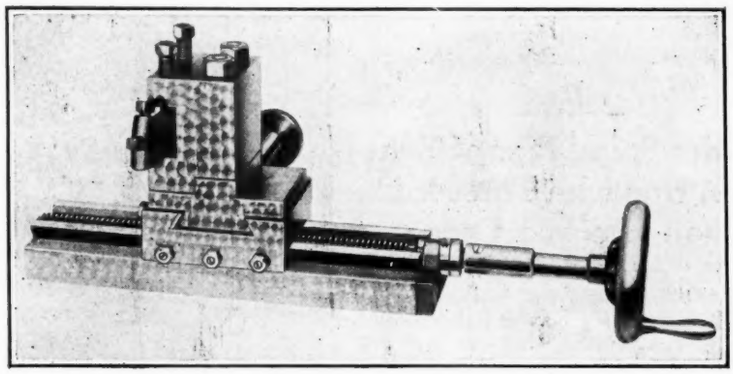
windings of this motor. A glass case was filled with a mixture of sand, iron filings and sawdust until the motor was half covered. An external fan on the motor churned this mixture, filling the air with it and completely surrounding the motor with thick dust. For two weeks the motor was run under these conditions, and when it was opened the windings were so clean that a permanent magnet brushed over them showed no trace of filings, nor had any sand or sawdust penetrated the cover.

Combination Grinding and Turning Tool

ALTHOUGH grinding of commutators is coming into more favor each year, there is still a demand for a device that can be mounted on the machine to hold a lathe tool for truing the commutator. To make it possible to grind a commutator or true it with a lathe tool, The Martindale Electric Company, Cleveland, Ohio, has recently developed a combination rest, shown in the figure, that can be mounted on a brush-holder stud. The figure shows a lathe tool mounted on the rest. For grinding, the tool holder is removed from the machine and the grinding stones mounted in its place.

When grinding, it is sometimes difficult to remove the ridge next to the risers on the commutator. These ridges can be removed with the lathe tool, which can then be replaced with grinding stones to true the surface of the commutator. One of the advantages of grinding is that it can be done with the machine operating at normal speed and can be operated from the normal source of power. A lathe tool requires that the commutator turn at a slow peripheral speed, and in the case of a motor the armature must be turned by an auxiliary source of power.

Where only the ridges are taken down with a lathe tool, the motor can be brought up to speed in the normal way. Then the power is cut off, the armature allowed to drift, and the turning done when the speed has dropped to a safe value. This operation repeated a few times will generally be sufficient to remove the ridges, after which the work is completed with the stone and the motor operating at normal speed.

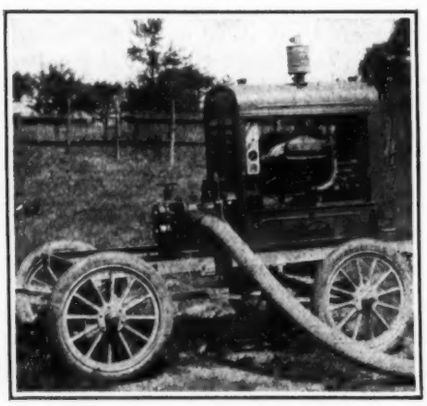


Lathe tool mounted on combination rest

Goulds Portable Gasoline-Engine-Driven Rotary Pumping Unit

TO MEET the demand for a self-contained portable pumping unit for industrial and other plants that have no adequate fire-fighting facilities and whose requirements will not justify the purchase of standard pumping installation, the portable engine-driven unit illustrated has been brought out by Goulds Pumps, Inc., Seneca Falls, N. Y.

The engine is a 4x5-in. four-cylinder unit operating at 1,100 r.p.m. The pump, which is connected to the power unit frame and to the engine flywheel housing by means of a bolted and doweled adapter casting, is fitted with a steel alloy shaft, chrome nickel steel pilot gears and hard phosphor-



Gasoline engine-driven pumping unit

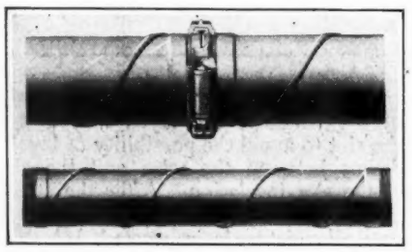
bronze cams that are machined to form, then ground together in the case. The pump shaft is carried on single-row deep-groove ball bearings and is connected to the engine shaft through a flexible coupling of the pin and buffer type. The pump has a 4-in. suction, a 2½-in. discharge and a capacity of 250 gal. at 100 lb. pressure.

The complete unit is mounted on a four-wheeled steel chassis equipped with hard-rubber tires.

Naylor Spiral Pipe of Toncan Iron with Threaded and Grooved Ends

THE Naylor Spiral Pipe Company, 1230 East 92nd St., Chicago, Ill., manufacturer of the Naylor Spiral Lock Seam pipe, announces that this pipe is now made of Toncan iron in sizes from 4 to 12 in. in diameter and 20-ft. lengths, fitted with grooved ends for Victaulic couplings (described in *Power*, April 27, 1926) and with threaded ends for standard screw fittings as illustrated, also with flanged ends for standard flanged fittings.

In manufacturing this pipe, a description of which appeared in the July 6, 1926, issue of *Power*, a strip of sheet steel is wound into a spiral shape, but instead of being riveted the edges are automatically flanged and formed into a four-ply lock seam laid up on the out-



Spiral lock-seam pipe with threaded and grooved ends for couplings

side of the pipe. For the higher pressures for which the pipe is now being made, the spiral seam is welded to the wall to give additional strength. In addition to the types of joints mentioned, the pipe is available with ends beveled or with slip joint for welding.

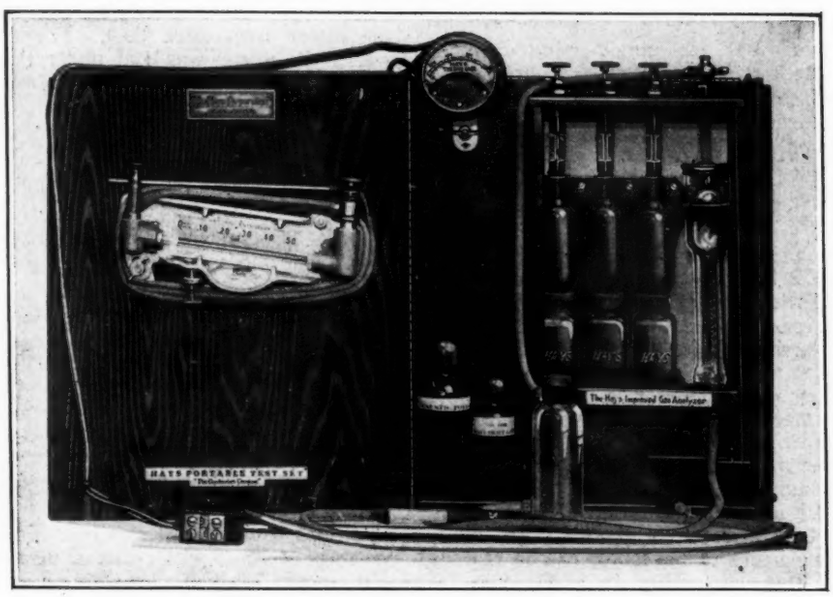
New Hays Portable Test Set

AN IMPROVED portable combustion test set offering a simple and convenient case of instruments for service men, combustion engineers, oil-burner dealers and others interested in the quick determination of combustion efficiency, has been brought out by the Hays Corporation, of Michigan City, Ind. The test set consists of a flue-gas analyzer, flue-gas thermo-gage and draft gage, compactly arranged in an oak carrying case, measuring 6½x11x17 in. and weighing less than 20 lb. When the door and top of the case are swung open, the instruments are ready for use. The analyzer is the standard Hays machine, either single-chamber style for carbon-dioxide only or of the three-chamber type for carbon-dioxide, oxygen and carbon-monoxide.

Mounted on the inside of the door is an inclined-tube draft gage with a micrometer screw for leveling. For convenience in setting the zero point opposite the end of the oil column, the scale is movable. A needle valve is provided to lock the oil in the oil well while the set is being transported. The scale has a range of ½ in. water column, but an auxiliary spirit level can be added to increase the range to 1 in., the scale reading in this case being multiplied by two.

As indicated in the illustration, the thermo-gage is a small portable indicating pyrometer with lead wire and special alloy thermocouple. This instrument has a pointer that indicates the temperature at the tip of the thermocouple. For the measurement of flue-gas temperature a range of 75 to 1,200 deg. F. is provided, although a 75- to 2,500-deg. F. range can be supplied if higher temperatures are to be measured. As an alternative for the thermo-gage a metal armored thermometer, with a range from 100 to 950 deg. F., can be supplied.

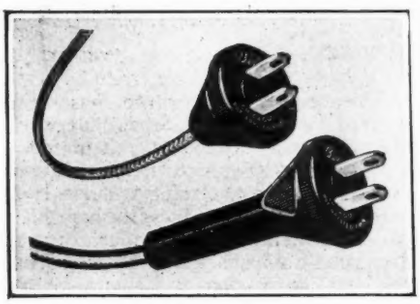
If it is desired to test the draft at one point, make a flue-gas analysis at another and measure the flue-gas temperature at still another point. This can be done, as the analyzer may be removed from the carrying case and hung on a nail driven in the wall. The thermo-gage also can be removed, as the slot in the bracket securing the gage to the case is elongated and will slip over the thumbnut after the latter has been loosened and turned parallel with the slot.



New Hays portable test set with gas analyzer, thermo-gage for furnace and flue-gas temperatures and inclined-tube draft gage

Belden Soft-Rubber Attachment Plug

THE Belden Manufacturing Company, 2300 S. Western Ave., Chicago, Ill., has added to its cord department a new soft-rubber attachment plug



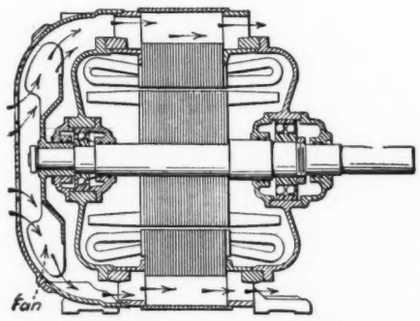
Soft-rubber attachment plugs

for use on the flexible cords of portable shop tools and other devices.

The plug is constructed of solid soft rubber and is practically indestructible. It is shaped to form a convenient grip for the fingers when plugging in or pulling out, and the insulating qualities make it especially adaptable for use in damp places. The plug is made in different shapes for various uses, and cords with plug attached are furnished in 10-, 20- and 50-ft. lengths.

Wagner Air-Jacketed Motors

AN AIR-JACKETED motor for use where dust, fumes and moisture are present in sufficient quantities to necessitate protection to the motor, has been developed by the Wagner Electric Corporation, St. Louis, Mo. The entire motor is surrounded by a jacket open at both ends, with a fan mounted



Section through motor showing air circulation

on a shaft extension, between the motor and its outer jacket.

The motors are new in external construction only. The frame housing, the motor proper and all bearings are substantially airtight. The end shield is made of cast iron, rib-reinforced and has a substantial grating which protects the fan and provides an opening for incoming ventilating air. The fan is of one-piece construction.

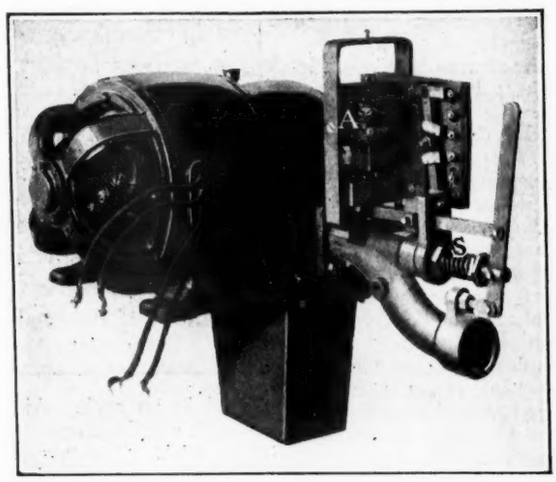
The stator is only part of the standard single-phase repulsion-induction and polyphase squirrel-cage motors subject to change in design. The exposed outer rim is grooved to increase radiation surface. The stator laminæ are welded together to lessen vibration and reduce magnetic noises.

The motors are fitted with double-row ball bearings, self-aligning in one end plate and deep groove in the other to take the end thrust. The bearings are grease lubricated and sealed in dust-proof housings.

Single-phase repulsion-induction motors may be had in sizes from 1 to 20 hp. and polyphase squirrel-cage motors in sizes from 2 to 30 hp. These motors are designed for a temperature rise not to exceed 50 deg. Centigrade.

Hydro-Electric Emergency Lighting Unit

TO PROVIDE a lighting unit for emergency lamps in hotels, schools, theaters and other public buildings, the Utilities Service, Inc., Troy, Pa., has developed a hydro-electric unit that is operated from the building water system. This unit is essentially an automatic starting miniature hydro-electric plant consisting of a direct-current generator having a waterwheel runner carried on its extended shaft, the complete equipment being mounted on a baseplate to form a compact self-contained unit, as shown in the figure.



Emergency unit assembled with cover removed from starting solenoid

The automatic starting feature consists of a needle nozzle which is manually closed against a spring *S* and held in that position by a latch. A solenoid *A*, which is connected across the line of the outside source of power, is arranged so that when it is de-energized, owing to failure of outside current, the solenoid core will drop and strike the latch a hammer blow and release the nozzle, which is instantly thrown open by the spring. An automatic switch for transferring the lighting circuit from the outside supply to the local direct-current generator is mechanically connected to the nozzle mechanism so that the nozzle and the switch operate in synchronism.

The generator is a special compound-wound type and gives approximately constant voltage from no load and runaway speed to full load and normal speed, the speed of the waterwheel varying in approximately inverse proportion to the load. This feature enables the machine to operate at any load between zero and full output with normal voltage and greatly simplifies the equipment because no speed governor is required.

The waterwheel is of the conventional impulse type. The housing is closed on one side by a cover, and leakage along the shaft, where it passes through the other side, is prevented by a frictionless centrifugal device.

Recent tests conducted on one of the 1,500-watt units, in the manufacturer's laboratory, indicated an over-all efficiency of 64 per cent from water delivered to the nozzle to electrical power in the lamp circuit. The electrical energy consumed by the automatic starting solenoid is about 20 watts, while the unit is standing by for an emergency.

Martindale Commutator Stones

THE Martindale Electric Company, 1260 West Fourth Street, Cleveland, Ohio, announces its new "double-duty" commutator stones for touching up commutators and slip rings.

One end of the stone is a coarse (cutting) grade and the other end a fine (finishing) grade. The stones are available in various sizes convenient for carrying in the pocket or tool kit.

Progress in Burning Coal*

By A. G. CHRISTIE

Professor of Mechanical Engineering, Johns Hopkins University

RECENT progress in coal burning may be credited to the following influences:

1. Increased furnace size and better combustion.
2. Increased furnace temperatures.
3. Better appreciation of radiant heat transfer.
4. Better appreciation of equipment and furnace requirements for various coals.
5. Improvements in stoker design.
6. Improvements in powdered coal systems.
7. Better instruments and improved furnace control.

Increased Furnace Size and Better Combustion

Ten years ago stokers were installed under boilers in furnaces with average heights of about 7 ft. 6 in. The advantages of large furnace volume were then becoming recognized and higher settings were employed on the newer boilers. There are furnaces in operation today with stokers having an average height of combustion chamber of 20 ft. or more. In 1920 the average furnace volume per 10 sq.ft. of boiler heating surface of 24 representative boiler installations with stokers was 1.9 cu.ft. In 1926 this average for 26 stoker installations had increased to 3.85 cu.ft. In 1926 the average furnace volume per 10 sq.ft. of boiler heating surface for 14 large powdered coal plants was 8.0 cubic feet.

These figures in the case of the stokers are significant. When the average height of setting is small, furnace temperatures are low and combustion is seldom complete when the flames enter the boiler tubes. The gases leaving the fuel bed are generally stratified, some with a deficiency of air, others with an excess. Proper mixing cannot be secured in a low furnace setting, and this results in losses due to incomplete combustion of the volatile matter. Enlarged furnaces with or without arches permit better mixing of the gases and thereby insure better combustion before the flames reach the boiler surface. This results in higher furnace temperatures which lead to increased boiler efficiency. Increased furnace volume has led to increased rates of combustion on stokers and to increased capacity of boilers. Some boilers are now operated at 500 to 600 per cent of rating during peak load.

When one speaks of B.t.u. per cubic foot of furnace volume with stokers, it is well to remember that the rate of heat liberation in some of the older furnaces was very high and that comparisons between present and former practice on this basis may be misleading.

Turning to pulverized coal, the first furnaces, such as at Lakeside and Cahokia, employed a long flame which was directed downward into the furnace from a vertical fantail burner placed in an arch. Air was admitted through openings over the whole of the front wall. The air and fuel intermingled with little disturbance except from the mixing and diffusion resulting from the upward turn of the flame. Flame temperatures were not high, as refractory walls with and without air cooling were used in these first installations. The rate of heat liberation in these early furnaces was about 10,000 to 12,000 B.t.u. per cu.ft. of furnace volume above the water screens.

> THE operating engineer is not so interested in the greatest number of B.t.u. that he can purchase for a dollar, but in the greatest amount of steam he can produce for a dollar's worth of fuel. Certain cheap low-grade coals can sometimes be burned only at comparatively low efficiencies, while high-grade coals generally burn at higher efficiencies. Based on the engineer's standards, the latter coal may be the best to purchase when freight rates form the larger portion of the total cost.

While large furnace volumes are still provided for powdered coal installations, present practice is to utilize these volumes more effectively, and heat liberation rates of 35,000 to 40,000 B.t.u. per cu.ft. of furnace volume are now in use. Several factors have contributed to this increase in fuel burning capacity. In the first place furnace walls in the last few years have either water-cooled refractories or bare metal walls instead of air cooled refractories. Additional turbulence in the furnace has been secured by admitting the secondary air at the burners in such a way as to create swirling and thorough mixing in the furnace, or, by producing cyclone conditions in the furnace by the so-called tangential firing from its four corners. Preheated air leads to more rapid ignition and combustion, and this also has been a contributing factor in producing greater utilization of furnace volume.

Increased Furnace Temperatures

A pound of coal may be burned in powdered form in a very short interval of time or may be allowed to smolder away for a longer time before it is completely consumed. The total B.t.u. liberated is the same in either case. The total air consumed in combustion may be assumed to be the same in both cases. Time is a factor in the dissipation of heat. Hence, in the first case, the products of combustion, having lost little heat by radiation or otherwise in the short interval of time required by the combustion process, will be at a tremendously higher temperature than those resulting from slow combustion.

A reduction of excess air, usually indicated by an increase in CO_2 in the furnace gases, results in an increase in furnace temperature, since a smaller quantity of furnace gases is available to absorb the heat generated by combustion provided combustion is complete. Hence modern stokers are designed with control of air admission to the different portions of the fuel bed according to their combustion requirements while thorough mixing of the gases in the furnace proper insures effective use of the air admitted to the coal bed. In the case of powdered coal thorough mixing of coal and gases and turbulence have permitted the use of low ratios of excess air.

Preheated air has also assisted in providing increased furnace temperatures.

Effect of Radiant Heat Transfer

The presence of large water-cooled surfaces in the low boiler settings, common a few years ago, was detrimental to good combustion. Flame temperatures were lowered due to the limited volume of the furnace, so that combustion was not complete when the flames entered the boiler tubes. Ignition was retarded by the presence of these large relatively cold surfaces. Hence it was customary in such settings to install reflecting arches as an aid to ignition, and also to expose relatively small areas of boiler surface to the fire to lessen cooling effect.

*From an address before the Philadelphia Section, A.S.M.E., at the Philadelphia Engineers Club, March 27, 1928.

Radiant heat is the most effective form of heat transfer. The transfer rate depends on the difference of the fourth powers of the absolute temperatures of the radiating and the receiving surfaces. Heat transfer by convection varies only as the difference of the temperatures of the gases and the tube surface. Hence heat absorption by radiant heat will be many times more effective than by convection. Transfer rates of 75,000 B.t.u. per sq.ft. of heat-absorbing surface per hour have been observed in practice with radiant heat.

Our increasing knowledge of radiant heat brought about a reconsideration of the proper disposal of heating surface in a boiler. These studies led to the complete exposure to the radiant heat of all the lower tubes of horizontal boilers and to the use of water-cooled tubes, forming a part of the boiler circulation system, for cooling the furnace walls and bottom, and in some cases of radiant superheater surfaces as furnace walls.

In the case of powdered coal evidence is accumulating that water-cooled surfaces on all walls has little influence on completeness of combustion or on flame temperature, if turbulence and other conditions favor rapid and complete combustion. The use of water-cooled walls with stokers requires careful study for they have limitations due to the fact that ignition may be delayed with some coals on certain stokers when too much cooling surface is used.

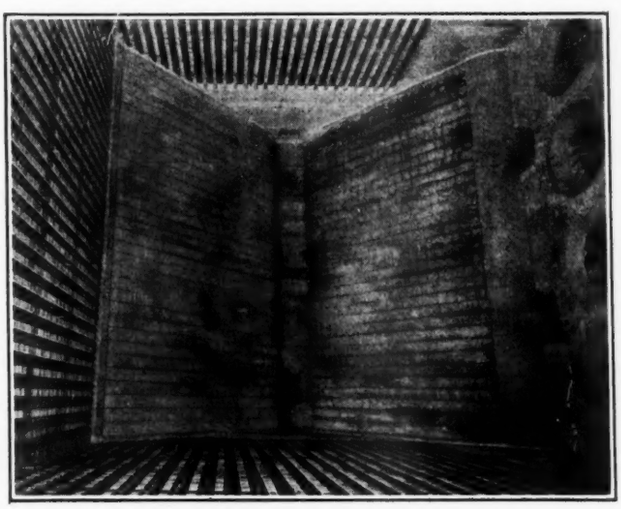
Luminous flames are now known to have much greater heat-radiating powers than incandescent flames and it is apparent that this must be given consideration.

One of the advantages of large furnace volumes that is sometimes overlooked is, it is possible even at the highest ratings to have combustion completed in the flame at some distance below the lowest tubes of the boiler. In the older low-set stoker furnace the limit of rating under which these would operate satisfactorily was often fixed by the deposition of liquid ash on the lowest tubes of the boiler. When glowing ash particles float in transparent gases in the upper few feet of a furnace, they will quickly radiate their heat to those water-cooled surfaces that they can "see." The greater the extent of these water-cooled surfaces, the greater the loss of heat by the ash. With extensive water cooling at the top of the furnace, these ash particles cool below their fusing point and instead of sticking to the tubes, they pass up through the boiler as solid dust particles. No slagging of the tubes should then occur.

Certain coals can now be burned to best advantage on underfeed stokers, others on chain-grate stokers, while still others seem best suited for powdered coal firing. For example, underfeed stokers do well on good West Virginia coals. Chain-grate stokers can burn fine anthracite satisfactorily, while the Belleville coal of Illinois and some Cape Breton coals can be burned advantageously in powdered form.

Improvements in Stoker Design

Early furnaces for stokers had solid brick side walls and bridge walls. When heavy loads were carried, considerable trouble was experienced with clinker adhering to the brick along the clinker line. Carborundum blocks are now widely used in these portions of the wall. These blocks are generally perforated and air-cooled. Cast iron blocks with air cooling are also used. The air is admitted through the perforations directly to the furnace, and unless mixed thoroughly with the furnace gases, it serves as a cool protecting layer along the upper side walls. The maintenance



Interior of latest Cahokia furnace

on these air-cooled sections is high, and the present trend is to substitute waterbacks along the clinker zone or to use large areas of water-cooled side walls in the furnace. Water cooling for stoker furnaces is still in the development stage, and no standards have been set for necessary surface areas. Ignition problems may limit water-cooled wall areas with chain-grate stokers.

Preheated air has introduced some new problems in stoker design. Highly preheated air may occupy twice the volume of normal air for the same weight. It is not possible to get this extra volume of air into some of the early stokers without excessive pressures and high leakage losses. In certain chain-grate stokers this air could not be properly distributed under the grates. The high velocity with which preheated air passes through the grate openings gives more activity to the fuel bed and promotes rapid ignition and combustion.

Grate bars in chain-grate stokers and tuyeres in underfeed stokers are kept cool under furnace conditions by the absorption of their heat by the combustion air during its passage over and through these parts. When highly preheated air is used, the temperature difference between metal and air is decreased. In order to maintain the metal parts at safe temperatures with preheated air, their heat-dissipating surfaces must be increased by the use of deeper links, by ribs, or by heat-dissipating fins, to transfer readily to the incoming air the heat from these metal parts which may be at higher temperatures than in older stokers due to the higher furnace temperatures.

Low air pressures in the windbox are desirable, as these indicate the supply of less power to the forced-draft fan. There is less blowing of the fuel into the ashpit than with high air pressures and also less slagging of boiler tubes.

The increase of stoker length indicated the desirability of some means to control combustion in the various zones of the stoker, and dampers have been provided to secure this control by adjusting the amount of air admitted to each zone. More recently, zone control has been made automatic. Provision is also made in some stokers to admit air over the fire at the front of the stoker to provide for the complete combustion of the rapidly evolved volatile matter. This is effective if the velocity of the air is sufficient to cause it to penetrate deeply into the furnace and to cause mixing and turbulence in the flame.

One of the leading recent improvements in furnace design for chain-grate stokers is the admission of secondary air through the front arch with high-volatile coals. This air is admitted where most needed, for the volatile matter frequently evolved so rapidly that it is difficult to supply enough air through the coal for their complete combustion.

Improvements in Burning Powdered Coal

As an indication of the rapid development in furnace capacity for burning pulverized coal, the case of the Cahokia boilers may be quoted. These boilers with 18,010 sq.ft. of heating surface each, were originally ordered in 1922 with air-cooled furnace walls and fantail vertical firing, which permitted operation with the particular coal available, up to 270 per cent of rating. The last addition, which went in service last fall (1927), contains the same size of boiler to which has been added an air preheater. The furnaces of the new boilers are water-cooled, and turbulent horizontal firing is employed. This furnace has already operated satisfactorily at 400 per cent rating and is expected to serve at 430 per cent rating.

The equipment for drying and pul-

verizing coal has been simplified and reduced. The first plants were equipped with rotary driers or waste-heat driers. Then steam driers were tried. The latest practice is to admit preheated air to the mills and to dry the coal as it is being pulverized. In unit mills the dust-laden air from the mill passes directly into the furnace. In England the vents from mill cyclones with central pulverizer systems are used as primary air, and the dust thus finds its way into the furnace. The dust nuisance from vents is thus eliminated.

Much still remains to be done in the development of pulverizers. This is evident when one considers the wide variety of mills available both for the central and the unit system. No mill type has so far definitely established a predominating superiority over the others.

The ash nuisance is one of the problems that still remains to be solved. Little or no attention was given to this factor in some of the early plants. In England, where coals of 20 per cent ash are burned in pulverized form in densely populated centers, the ash precipitation is consdiered a grave nuisance. Public policy in America may demand that engineers prevent this discharge of great quantities of dust from the chimneys of pulverized coal plants. Dust separating or precipitating devices are now under development which may largely eliminate this discharge from chimneys.

A promising development is the slagging furnace. The bottom of these powdered coal furnaces is refractory lined like the hearth of an open-hearth steel furnace. The ash collects in liquid form and is tapped off from time to time as slag. This may prove an effective way to handle ash.

The relative merits of the unit system and central systems of pulverized coal firing have been much discussed. The unit system is being installed in many new plants and its use is extending rapidly. Its first cost and maintenance are lower than the similar costs with the central system under most conditions while its efficiency also compares favorably. Its adoption is forcing the manufacturers of the central system to bestir themselves and developments tending to simplify and lessen the cost of the latter system may be expected.

Better Instruments and Improved Furnace Control

No factors have contributed more to improvements in burning coal than the provision of indicating and recording instruments to guide the firemen, and the development of full automatic control. The use of instruments has made it possible to apply intelligence to the combustion process instead of mere muscle for coal-passing. The firemen can now tell quite accurately the conditions in his furnace and can judge by his instruments what changes should be made to remedy any imperfect conditions. Furthermore, the instruments tell him immediately the effect of any changes that he may make. There is no excuse today for any boiler room to be without proper instruments, or for neglect to use those that are provided.

Another modern development is automatic combustion control where the fuel and air are automatically proportioned at all loads to meet some fixed set of conditions. Great progress has been made in perfecting these devices which tend to eliminate the variables of the human element.

Conclusions

This survey of the progress in the burning of coal leads to the following conclusions regarding probable future trends.

1. Furnace sizes for stokers and for powdered coal will not be decreased and may even be increased.

2. The fuel-burning capacities of furnaces will be increased by better firing methods, further mixing of gases in the furnace and in the case of stokers improved methods of distributing air to the fuel bed.

3. The use of preheated air will extend. In the case of pulverized coal the economic limit to the degree of preheat will probably be fixed by the size and cost of large preheaters. With stokers there may be an economic limit to the best degree of preheat, and economizers may be used between the air preheaters and the boiler.

4. New furnaces will aim to secure the highest furnace temperatures possible to assure rapid and efficient transfer of heat.

5. Water-cooled walls to permit high furnace temperatures will be used to an increasing extent.

6. Further modifications in boiler design may be expected to permit still better utilization of radiant heat transfer in the furnace.

7. Modifications of furnace designs may be expected to follow more extensive study of the problem of slag formation on the lower tubes of boilers. Transparent gases below the tubes and extensive radiant heat absorbing surfaces at the top of the furnace may help to solve this difficult problem.

8. Improvements in stokers may be expected through better distribution of air below and above the fire and automatic control governed by furnace conditions, of this air, together with further adaption to the use of preheated air.

9. Improved drying and pulverizing methods, mixing burners to secure the best degree of turbulence in a water-cooled furnace, and more intense heat evolution per cubic foot of furnace volume, will probably characterize future pulverized coal developments.

10. The intense competition of the unit and central systems of pulverized coal firing must undoubtedly lead to the simplification and decrease of the costs of each system and to improvements in the efficiency of both systems.

11. More extensive use of control instruments for furnaces will characterize newer plant design.

Negligent Starting of Gas Engines

By Arthur L. H. Street

ONE who uses a dangerous method of starting an engine, appreciating the danger, has no valid claim for damages against his employer for naturally resulting injuries, holds the Arkansas Supreme Court, in the case of Standard Oil Company vs. Gray, 300 South Western Reporter, 2d Series, 405. But this decision is to be understood as applying only to ordinary actions at law and not to cases covered by workmen's compensation acts, as to which latter cases negligence and contributory negligence are usually immaterial factors.

Gray was injured through backfiring of a gas engine after he had started it and while he was replacing the cap on the air mixer. He and his co-workers had removed the cap to facilitate starting the engine, and the court finds that it was that removal that caused the accident. The Court said:

"There was no emergency requiring him suddenly to select the method for doing the work, or excusing him from attempting the least safe way. He was working under his own initiative or direction in starting the engine, working according to his preference at the time, and, being familiar with this method of doing the work and necessarily knowing and appreciating the danger incident thereto, in attempting it he must be held to have assumed the risk. . . .

"He carelessly and unthoughtedly brought his face over the air mixer in reaching for the top to replace it and without any necessity for doing so, and, although he stated he had not known of any explosion from a backfire coming through the open air mixer after the engine was started, he knew that the top was put on such mixer to prevent the explosions from backfire coming out that way, and also that the top was off, necessarily exposing him to any danger that might result therefrom.

"There does not appear to be any reasonable excuse for the careless manner of bringing his face near to and over the open mixer in attempting to replace the top thereon, and in so doing he was guilty of negligence contributing to his own injury also, and but for which such the injury would not have occurred."

NEWS *of the* FIELD

Welding Society Will Cover Many Fields At Annual New York Convention

May 25-27 Meeting Will Feature Pressure Vessels, Structures, Piping, Automobiles, Research and Procedure Standardization

PAPERS on the welding of pressure vessels, structures, piping and automobiles, with reports on procedure standardization and the research projects of the American Bureau of Welding will make the next annual meeting of the American Welding Society, to be held in the Engineering Societies Building, New York, on April 25, 26 and 27, another milestone in the progress of the Society and the development of the welding art.

On Wednesday morning, April 25, the Pressure Vessels Committee, of which E. H. Ewertz is chairman, will present the procedure specifications to be followed in making the tanks and specimens called for by the research plans of the committee.

Progress in structural welding has been cautious but steady, and the last two years have seen the erection of several welded steel-frame buildings and a number of bridges, with numerous smaller applications to structural repairs and additions, house building, etc.

That the future possibilities in this field of application are recognized is indicated by the serious work of the Structural Steel Welding Committee, of which J. H. Edwards, Chief Engineer of the American Bridge Company, is chairman. Wednesday afternoon will be devoted to a meeting of this committee with a review of progress to date, reports of assignments, etc.

A short business session on Thursday morning will be followed by a paper on "Welding the Ford Car." Because of the unprecedented interest in the new Ford model, and the unusual applications of welding it embodies, this paper is expected to attract the attention of engineers in general as well as of welding experts and automotive specialists. After the Ford paper a special luncheon for members of the Society will be served in the Engineers Club.

"Procedure standardization in welding. Qualifications of welders, inspection and supervision," is the subject of a report to be presented by H. H. Moss and A. M. Candy at the Thursday afternoon session. Messrs. Moss and Candy will outline the progress made in standardizing procedure and establishing effective supervision of welding personnel.

Following a discussion of this report, J. H. Edwards will speak on Structural Steel, A. O. Miller and L. H. Burkhart on Pressure Vessels and A. W. Moulder on Pipe Welding.

The annual dinner, to be held on Thursday evening, will be a stag affair with entertainment of unusual interest.

Friday morning will be devoted to a meeting of the Board of Directors.

At the final session of the convention, on Friday afternoon, the American Bureau of Welding, which is the research department of the American Welding Society, will review the progress of the various research committees, elect officers and lay plans for future activities.

Pulverized Fuel Aboard Ships Discussed by A.S.M.E.

Pulverized fuel aboard ships was the subject of a paper presented by Carl J. Jefferson, head of Fuel Conservation Division of the U. S. Shipping Board, at a meeting of the Metropolitan Section of the A.S.M.E. on Monday evening, April 2.

After briefly reviewing the experiments and tests carried out on a Shipping Board boiler at the Philadelphia Navy Yard[1], Mr. Jefferson described the installation aboard the steamship "Mercer" and told of some of the operating experiences on the first trip at sea.

The steam-generating equipment on the "Mercer" consists of three Scotch marine boilers, each of which has three 42-in. diameter furnaces. The boilers were originally equipped to burn fuel oil, but as a result of the test conducted at the Navy Yard two of the boilers have been converted to pulverized coal, the third being retained as an oil-fired unit.

The present coal preparation and burning equipment consists of three Kennedy air-swept ball mills and one Peabody burner per furnace, or six in all. The coal is distributed to the three burners of each boiler by a distributor having an independently driven paddle designed to give uniform coal mixture to each burner. The raw coal is elevated from the bunker to a crusher overhead then flows by gravity to the mill feeder.

The feeder end of each mill is supplied with air at 250 deg. from a Howden air heater installed at the gas exit of each boiler. The coal used on the trip had a calorific value of 12,000 B.t.u. and 14 per cent ash.

On the first trip of the "Mercer" to Rotterdam, Germany, made during November and December, 1927, several operating difficulties were encountered. None of these, however, were serious or necessitated the equipment being out of service for any length of time. During the eastbound trip about 3 in. of slag collected in each furnace. This was removed while in port, and was not found to be a difficult job.

In Mr. Jefferson's opinion the experience with pulverized coal aboard the "Mercer" has demonstrated the safety and reliability of this fuel aboard ship. He pointed out that unusually fine pulverization and a high flame turbulence were essential with the small combustion space of the Scotch boiler. In his opinion at least 75 per cent of the coal should pass through a 300-mesh screen.

[1]See Power, Dec. 27, 1927.

Construction Starts on Steam Plant Near Charlotte, N. C.

The Duke Power Company has begun work on a 440,000-kw. steam-electric plant at River Bend on the Tatawba River, twelve miles from Charlotte. Excavation for the foundation of the first unit of 110,000 kw. is now under way.

The generating equipment of the first unit will include two steam-turbine generators, each with a capacity of 55,000 kw. The turbines are designed for four-stage heating of feed water. Steam will be generated in four boilers at a pressure of 400 lb. per sq.in. and a total temperature of 725 deg. F. The boilers will be fired by a unit system of pulverized fuel. Space has been provided for the storage of 100,000 tons of coal at the plant.

The location of the plant at a bend in the river provides an excellent arrangement for handling the circulating water. The circulating-water inlet is on the upstream side of the bend, and it is discharged through an 1,800-ft. tunnel leading to the downstream side of the bend in the river. This arrangement makes recirculation of the cooling water impossible.

Expansion of Steam Plants Predicted for South

George A. Orrok addressed a joint dinner meeting of the Raleigh Engineers Club and the Raleigh section of the A.S.M.E. at the Yarborough Hotel on March 26.

Mr. Orrok expressed the opinion that the Southeastern States will experience a great power development in the next ten years. Last year this section produced over five billion kilowatt-hours, and this, he predicted, will be doubled soon.

North Carolina, he asserted, is favorably situated for steam power development, and it will be only a matter of time before the Deep River coal fields are brought into production for an enormous supply of cheap fuel.

Power and Prosperity Linked by Geological Survey Report

Present high standards of living are largely the result of the increased use of power in industry and the supplanting of human labor by mechanical devices, according to statements made in a report (Water Supply Paper 579) just issued by the United States Geological Survey. The report, which is divided into three sections, covers power capacity and production in the United States and their relation to economic conditions. Discussing the development of power equipment in the United States, C. R. Dougherty declares, in the first section of the paper, that "the drudgery of the struggle for existence has largely been transferred to machinery vitalized by mechanical power, thus making universal education possible by sparing youth from the farm and factory." He points out that in 25 years weekly hours of labor have decreased by about 9 per cent, while "real wages," measured in purchasing power, have increased 40 to 50 per cent.

Over 3,000 Plants in All

In the second section A. H. Horton quotes statistics to show that on Jan. 1, 1927 the water power capacity in the United States was 11,720,983 hp. The number of plants producing this power was 3,390, of which 1,565 having a capacity of 9,961,202 hp., were public utility and municipal plants. The remaining 1,825 plants, with a capacity of 1,759,790 hp., were classified as manufacturing and miscellaneous. As to potential power Mr. Horton states that about 35 million horsepower is available 90 per cent of the time and 55 million half of the time.

"In 1919," says Mr. Horton, speaking of steam central stations as a group, "a ton of coal generated 625 kw.-hr., and in 1926 the corresponding figure was 1,025 kw.-hr. If there had been no improvement from 1919 to 1926 the consumption of coal would have been 100 million tons more." These figures, Mr. Horton points out, are significant because they are based on the operation of all utility plants rather than on a selected few.

Predicts Water-Power Development

Water-power developments since 1869 are traced by R. W. Davenport in the third section of the report. Licenses issued under the Federal waterpower act on Jan. 1, 1927, he says, covered the completion of a total installed capacity of 3,200,000 hp. in the next ten years. "Such of these projects as fail will be more than offset by new projects that will be licensed hereafter," he states. "In addition to these developments under the Federal Water Power Act, there will continue to be new developments and increasing installations at former plants not requiring federal authorization. Steady growth in water-power development seems to be assured for many years."

Duplicate Effort Decried In I.E.C. Report

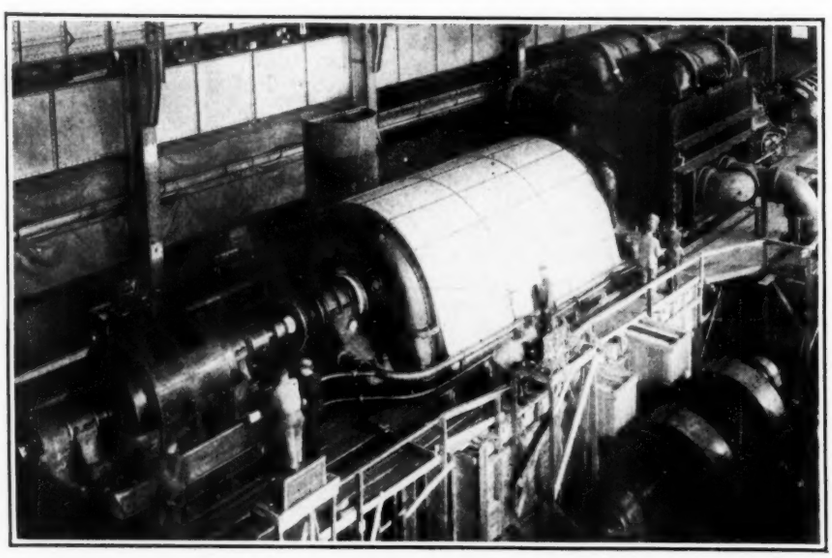
A warning against duplication of effort by international congresses and technical meetings is sounded in a statement just issued by the London office of the International Electrotechnical Commission. The report says, in part: "International congresses and meetings to discuss technical subjects are on the increase and so also are the possibilities of overlapping of effort. While these facts are quite well recognized, until recently apparently no concerted action has been taken to attempt to minimize, if not to prevent, this state of affairs.

"In January of this year a first meeting of the unofficial 'Comite d'Entente,' as it was suggested it should be called, was held in London at the offices of the I.E.C. An interesting exchange of information took place regarding dates of future meetings and in one or two cases of the preliminary programs. It was felt that if information of such a character regarding dates and programes could be exchanged at infrequent intervals, say once annually, it would be bound gradually to lead to most helpful co-operation and be of advantage to the delegates at the many international meetings.

Suggest Closer Co-operation

"The question of the co-operation between international organizations by joint international committees as well as by observers was also touched upon. Finally, it was decided to keep the unofficial committee in being with the I.E.C. as convener and to call another meeting a year hence by which time the various organizations represented would have had time to give their official decision, which in most cases it is anticipated will be favorable, regarding the permanent establishment of such a committee. It is also hoped that other international organizations in the technical field will be interested in this co-operative idea which, while leaving each organization entirely free, yet provides a kind of clearing house through which information may be exchanged and administrative matters discussed in a free and friendly manner."

Testing 94,000 kw. Unit



This tandem compound unit for the Southern California Edison Company is the largest completed turbine generator in existence. It consists of a high-pressure cylinder and a double flow low-pressure element arranged to exhaust into four vertical condensers. The main generator is rated at 90,000 kw. and a service unit on the same shaft is rated at 4,000 kw.

City of Los Angeles Orders Largest Waterwheel

The Bureau of Power and Light of the City of Los Angeles has awarded a contract to the Allis-Chalmers Manufacturing Company at Milwaukee, Wis., for the last impulse wheel unit to be installed at the San Francisquito No. 1 Plant. It will be of 24,000-kw. maximum capacity, which is double that of each of the four units already installed and operating under a head of 800 feet.

Although this unit is not of exceptionally large capacity, it establishes a new record as to physical size. It will have two jets, each 14 in. in diameter, and a wheel of about 176-in. diameter. It will operate at 143 r.p.m. (50 cycles), which is the lowest speed of any hydro-electric impulse unit of large capacity. Because of this low speed the generator will be the largest of its kind ever built.

Efforts are being made, both by the Bureau of Power and Light and by the manufacturer, to have this unit in commercial service before the end of this year, although the contract for the equipment has just been received by the manufacturer.

Flood Control Bill Passed By the Senate

General surprise was caused when the Senate, after an hour's debate on March 28, passed the Jones flood control bill by a vote of 70 to 0. The action was the more surprising in that the vote came after the committee, over the protest of the administration, had eliminated all local payments toward the construction of the new project, had broadened the tributary provision, had expanded the board of review and had made sweeping provision for the compensation of all damages.

Following the action in the Senate the House committee which just had reported the Reid bill, voted 14 to 6 to substitute the Jones bill, which was amended so as to extend the tributary provision to all rivers of the Mississippi Valley system. Authority was given to use $5,000,000 of the $325,000,000 authorized by the bill to add to the $7,500,000 carried in the War Department appropriation bill for the surveys of tributaries.

As passed by the Senate and accepted by the House committee, the engineering board is to be composed of the Secretary of War, the Chief of Engineers, the president of the Mississippi River Commission and two civil engineers from civilian life. This board is to harmonize engineering differences and is empowered to report to Congress any alternate plan which it may decide is better. Another House amendment provides a salary of $10,000 a year for the president of the Mississippi River Commission and $7,500 for each member of the Commission.

It is anticipated that the bill will encounter in the House no such easy sailing as it had in the Senate. Indications are that important amendments will be made when the bill comes before the Representatives.

Lehigh Announces Program For Welding Symposium On April 16

Lehigh University has made public the complete program for the "Symposium of Welding," which will be held April 16 at its engineering laboratories, Bethlehem, Pa., with morning, afternoon and evening sessions.

At the morning session, the "Efficiency of Welding in Repair Work" will be discussed by A. F. Keogh, President, Sound Welding Company, New York City, John C. Reed, Bethlehem Steel Company, Steelton, Pa. and J. H. Weiss, Welding Foreman, West Albany Shops, New York Central Railroad. These speakers will be followed by other practical welders, makers of welding equipment and consulting engineers.

Special demonstrations will be staged in the afternoon. These will include working exhibits of industrial welding apparatus and tests of full sized welded specimens in an 800,000 lb. compression machine.

The "Flow of Welding Metal" will be explained at the evening session by J. B. Green, President, Fusion Welding Corporation, Chicago. The actual transfer of metal from welding rod to weld will be shown by motion pictures.

Preliminary reports indicate that many out-of-town engineers will attend the symposium because of the wide interest in welding and the success of previous conferences of this nature.

Colonel J. L. Walsh Goes to Guardian Detroit Bank

Col. James L. Walsh has resigned as a vice-president of the McGraw-Hill Publishing Company, it was announced last week, to become a vice-president and member of the board of directors of the Guardian Detroit Bank in Detroit. He will retain his membership on the board of directors of the McGraw-Hill organization.

Prior to entering the publishing field, Colonel Walsh was for many years with the Bankers Trust Company, serving it as resident officer in Chicago, in charge of all Middle Western business. He is a member of the finance committee of the American Society of Mechanical Engineers and chairman of its National Defense Division.

In announcing the election of Colonel Walsh to be a vice-president, the directors of the Guardian Detroit Bank stated that his selection is another step in the development of the Guardian group, the other units of which are the Guardian Trust Company and the Guardian Detroit Company.

Obituary

LINUS W. LLEWELLYN, president of the Walsh & Weidner Boiler Company, of Chattanooga, Tenn., died at his home in that city on March 19 in his 59th year. In addition to his position as head of the boiler company, Mr. Llewellyn was prominent in the business, industrial and social life of the city. Coming to Chattanooga in his early teens, his first employment was a clerk for the First National Bank. Rising rapidly in the business world, he became identified with many of the city's leading industries. At the time of his death, in addition to being head of one of the largest boiler manufacturing companies in this country, he was treasurer of the Provident Life & Accident Company, Secretary of the Richmond Spinning Company, Secretary of the Chattanooga Implement Manufacturing Company and President of the Chattanooga Rubber Tire Works. He was also a director of the American Trust & Banking Company and in the Interstate Life & Accident Company.

Personal Mention

ADAM GSCHWINDT, who has been manager of the Rockford Electric Company, Rockford, Ill., since 1913, has also assumed the duties of manager of the Rockford Gas Light & Coke Company, succeeding Henry S. Whipple who will become chairman of the board of directors.

F. G. BAENDER, designing engineer for the International Motor Company, has been appointed head of the mechanical engineering department at Oregon State College, Corvallis. He succeeds J. R. DuPriest, who resigned last summer. Mr. Baender will assume his new duties next fall.

E. W. NICK, president of the Northern Equipment Company, Erie, Pa., recently sailed for a business trip in Europe.

Society Affairs

A.S.M.E., METROPOLITAN SECTION, Engineering Societies Bldg., 29 West 39th St., New York City, April 11, "Proposed Method of Rating Steam Generator Units," by W. A. Shoudy, consulting engineer, New York City, and W. H. Jacobi, manager of the Keokuk Steel Casting Co., Keokuk, Iowa.

A.S.M.E., METROPOLITAN SECTION, Engineering Societies Bldg., 29 West 39th St., New York City, April 17. "Performance Records of Oil Engine Locomotives," by Herman Lemp, consulting engineer, Ingersoll-Rand Co.

NATIONAL ASSOCIATION PRACTICAL REFRIGERATING ENGINEERS, Philadelphia Chapter, Hotel Stephen Girard, Chestnut St., Philadelphia, Pa., April 19. Thomas Shipley, president, York Ice Machinery Corporation, will speak on "More Recent Developments in Evaporating Systems."

A.S.M.E., PHILADELPHIA SECTION, Engineers Club of Philadelphia, April 23-24. The technical sessions of this meeting are devoted to papers on material handling problems. Two papers are of interest to *Power* readers, one by James R. McCausland, supt., Coal Bureau and Steam Heat Section, Philadelphia Electric Co., on "Methods and Equipment for Fuel Handling and Ash Disposal," and a paper on "Handling of Ashes by Hydraulic System," by Arthur M. Quinn, engineer, the Allen-Sherman-Hoff Co. These papers will be presented at the 2:00 p.m. technical session on April 24.

Business Notes

THE DEARBORN CHEMICAL COMPANY, Chicago, announces the appointment of E. M. Converse as sales manager of both the stationary and specialties departments. He relieves W. A. Converse, secretary and chemical director, who will now devote his attention to matters of general company operation.

THE C. O. BARTLETT & SNOW COMPANY, of Cleveland, Ohio, announces the appointment of W. H. Norrington, 30 Church St., as its representative in New York City and vicinity. Mr. Norrington was formerly associated with the Robins Conveying Belt Company as sales engineer and later general sales manager of that company.

THE DAMPNEY COMPANY OF AMERICA, Hyde Park, Boston, Mass., anannounces that the sale of its Apexior protective coatings for power-plant equipment will be handled in southern Minnesota by the Kent Engineering Company, 732 Builders Exchange, Minneapolis.

CASTLE & WILSON—The interest of Edward F. Wilson, in the partnership of Castle & Wilson, Pittsburgh, Pa., has been purchased by James T. Castle, who will continue the business as heretofore.

THE CARBONDALE MACHINE COMPANY, of Carbondale, Pa., announces the removal of its Pacific Coast offices to the Western Pacific Building, 1031 So. Broadway, Los Angeles, Calif.

Coming Conventions

American Association of Engineers, annual convention, El Paso, Texas, June 4-6; M. E. McIver, secretary, 63 Adams St., Chicago.

American Institute of Electrical Engineers, Balitmore Regional Meeting, District No. 2. April 17-19; New Haven Regional Meeting, Northeastern District, No. 1, in May; Summer Convention, in Denver, June 25-29.

American Institute of Refrigeration, Washington, D. C., May 10-11.

American Order of Steam Engineers, convention at Atlantic City, N. J., June 11-14, and exhibition with American Supplymen's Association. Address Fred L. Jahn, Watson of McDaniel Company, 146 N. Seventh St., Philadelphia.

American Refractories Institute, annual meeting at White Sulphur Springs, W. Va., May 8-9; Dorothy A. Texter, secretary, 2202 Oliver Bldg., Pittsburgh.

American Society of Refrigerating Engineers, meeting at Detroit, June 4-7; W. H. Ross, secretary, 37 West 39th St., New York City.

American Society of Heating and Ventilating Engineers, Summer meeting at West Baden Springs Hotel, West Baden, Ind., June 26-29; A. V. Hutchinson, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers, spring meeting in Pittsburgh, May 14-17; Calvin Rice, secretary, 29 West 39th St., New York City; Twin-City regional meeting at St. Paul, Aug. 27-30; Boston regional meeting, Oct. 1-3.

American Society for Testing Materials, Atlantic City, June 25-29.

American Water Works Association. Annual meeting, Hotel Fairmont, San Francisco, June 11-16; W. M. Niesley, 170 Broadway, New York City.

American Welding Society, annual meeting, 33 West 39th Street, New York City, April 25-27; M. M. Kelly, Secretary.

Association of Iron and Steel Electrical Engineers, annual convention and Iron and Steel Exposition at Hotel Stevens, Chicago, June 25-29.

Indiana Fuel Conference at Purdue University, Lafayette, Ind., April 5-6.

National Association of Power Engineers, annual convention at Detroit, Sept. 11-15, and concurrently National Exhibitors' Assn. exhibit; Fred Raven, 417 South Dearborn St., Chicago. New England States Association convention at Hartford, Conn., June 21-23; K. W. Lundberg, secretary. Foot Guard Armory, Hartford.

New Jersey State Convention at the Plaza Hotel, Journal Square, Jersey City, N. J., June 2-3; T. M. Gray, State Secretary, 46 West 51st St., Bayonne, N. J.

National Board of Boiler and Pressure Vessel Inspectors, meeting at Erie, Pa., June 18-20.

National Electric Light Association, Convention and exhibition, Atlantic City, N. J., June 4-8; A. Jackson Marshall, secretary, 420 Lexington Ave., New York City.

National District Heating Association, annual meeting at Ambassador Hotel, Atlantic City, June 12-15; D. J. Gaskill, sec., 112 West 4th St., Greenville, Ohio.

Stoker Manufacturers Association, fall meeting at Greenbrier Hotel, White Sulphur Springs, W. Va., Oct. 22-24.

Universal Craftsmen Council of Engineers, Newark, N. J., Aug. 7-10.

Second Bituminous Coal Conference will be held at Pittsburgh, Nov. 19-22.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard...	New York.....	$2.25@$2.56
Kanawha.....	Columbus.....	125. @ 1.60
Smokeless.....	Cincinnati.....	2.25
Smokeless.....	Chicago.....	2.25@ 2.50
S. E. Kentucky...	Chicago.....	1.35@ 1.50
Steam.....	Pittsburgh.....	1.40@ 1.65
Gas Slack.....	Pittsburgh.....	1.10@ 1.25
Big Seam.....	Birmingham...	1.50@ 2.00
Anthracite (Gross Tons)		
Buckwheat.....	New York.....	$2.75@$3.00
Birdseye.....	New York.....	1.60

FUEL OIL

New York—Apr. 5, industrial use, tank-car lots, 28@34 deg., Baumé, 4⅜c. per gal.; 36@40 deg., 5⅜c. per gal., f.o.b. Bayonne, N. J.

St. Louis—Mar. 28, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.55 per bbl.; 26@28 deg., $1.60 per bbl.; 28@30 deg., $1.65 per bbl.; 30@32 deg., $1.70 per bbl.; 32@36 deg., gas oil, 4.4c. per gal.; 38@40 deg., 5¼c. per gal.

Pittsburgh—Mar. 29, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5¼c. per gal.

Philadelphia—Mar. 29, 26@30 deg., $1.90@$1.97 per bbl.; 13@19 deg., $1.15 @$1.22 per bbl.; 22 plus, $1.51@$1.58 per bbl.; 27@30 deg., $2.10@$2.17 per bbl.

Cincinnati—Apr. 3, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 4.9c. per gal.; 26@30 deg., 5.15c. per gal.; 30@32 deg., 5⅛c. per gal.

Chicago—Mar. 17, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl.; 22@26 deg., 85@90c. per bbl.; 26@30 deg., 90@95c. per bbl.; 30@32 deg., $1.10 per bbl.

Boston—Apr. 2, tank-car lots, f.o.b. 12@14 deg. Baumé, 4¼c. per gal.; 28@ 32 deg., 5½c. per gal.

Dallas—Mar. 24, f.o.b. local refinery, 26@30 deg., $1.40 per bbl.

THE MIDEKE SUPPLY CO., 100 East Main St., Oklahoma City, Okla., has recently been appointed to represent Foote Bros Gear & Machine Co. on its line of IXL speed reducers, gear products and general transmission machinery, in Oklahoma City and vicinity.

THE WHITNEY CORPORATION, Harvey, Ill., announces that F. P. Walsh has been appointed manager of the crane department and R. H. Moore manager of the foundry equipment department.

Trade Catalogs

CRANE OPERATION AND MAINTENANCE—Whiting Corporation, Harvey, Ill., manufacturer of electric cranes, has recently issued Bulletin 179, superseding No. 159. This is a handbook on the operation and maintenance of electric cranes made by this company. It gives photographs and drawings of all the parts of these cranes and tells how to adjust them and maintain them.

ROTARY CAR DUMPERS — Roberts & Schaefer Co., 418 Oliver Bldg., Pittsburgh, Pa., in a new Bulletin No. 103, describes the construction and use of rotary car dumpers for unloading such materials as coal. In addition, the auxiliaries needed for the operation of these dumpers, such as feeders, are described.

GATE HOISTS FOR HYDRO-ELECTRIC INSTALLATIONS—D. J. Murray Manufacturing Co., Wausau, Wis., has published a new bulletin describing hoists for use in connection with the overflow gates of power dams, storage reservoirs and irrigation works. This bulletin describes and illustrates the construction of these gate hoists, and also gives a number of photographs and descriptions of various typical installations.

WATER-JET EXHAUSTERS AND COMPRESSORS—The Schutte & Koerting Co., has issued a revised bulletin on water jet exhausters and compressors. This bulletin shows and illustrates the installation and operation of jet exhausters and their application to various types of equipment. Capacity curves are included that show the time required for a No. 4 exhauster to evacuate a 20-cu.ft. tank.

STEAM TURBINES—Murray Standard Steam Turbines are described in bulletin T-100, published by the Murray Iron Works Company, Burlington, Iowa. In this bulletin cross-section drawings illustrate the detail of the turbine and governor design, and photographs show typical installations.

MOTORS—Bulletin No. 200-D, published by the Lincoln Electric Co., Cleveland, Ohio, describes a line of electric motors the frames of which are made of welded steel. One of the striking illustrations in the catalog shows a Linc-Weld motor in operation under water. The motors described in this catalog range in size from 1 to 500 hp.

FORCED DRAFT BLOWERS—A comprehensive catalog No. 32 on aëro valve blowers will be sent to interested parties by the Bayley Blower Company, Milwaukee, Wis. In this publication are included dimensions and capacities of various size blowers.

AIR COMPRESSORS—A pamphlet showing air compressors direct connected to oil engines has been issued by the Ingersoll Rand Company, New York City. Costs of operating such units are included along with numerous illustrations of installations.

WELDED PIPE JOINTS—Pamphlet No. 330, published by Semet-Solvay Engineering Corporation, 40 Rector St., New York, shows the Steer welded sleeve pipe joint.

GAS BURNER—The Lee B. Mettler Company, 406 South Main Street, Los Angeles, Calif., have published a folder describing the operation of the Mettler Gas Burner.

NEW PLANT CONSTRUCTION

Calif., Los Angeles—City Power & Light Commission will build a power distribution station 15,000 hp. capacity at Broadway and Wyoming St., by day labor. Estimated cost including equipment $200,000.

Calif., Los Angeles — Developers, Inc., headed by John A. Quinn and several property owners, awarded contract for the reconstruction of a group of mercantile buildings at 7th St. between Figueroa and Lucas Sts., to J. V. McNeil Co., 5860 Avalon Blvd. Estimated cost approximately $6,000,000.

Calif., Los Angeles—United Pacific Securities Corp., 821 Security Title Insurance Bldg., will build a 13 story hotel including electric heating system, elevators, etc., at Wilshire Blvd. and Commonwealth Ave. Estimated cost $1,000,000. N. W. Alpaugh, 2404 West 17th St., is architect. R. Park, 2404 West 17th St., is engineer.

Calif., San Diego—Balboa Hotel Corp. plans the construction of a 16 story hotel. Estimated cost $1,000,000. F. W. Stevenson, Spreckels Theatre Bldg., is architect.

D. C., Washington—Freemans Hospital, is having plans prepared for addition to power plant. Estimated cost $52,000.

Ill., Chicago — East Chestnut Building Corp., c/o R. S. DeGoyler & Co., 307 North Michigan Ave., Archts., is having plans prepared for a 26 story apartment building at Chestnut and De Witt Sts. Estimated cost $2,500,000.

Ill., Chicago—B. F. Lindheimer, 77 West Washington St., awarded general contract for a 22 story office and stores building at Jackson Blvd. and Franklin St. to McLennan Construction Co., 307 North Michigan Ave. Estimated cost $2,500,000.

Ill., Chicago—South Park Comrs., 5700 Cottage Grove Ave., will receive bids until May 16 for an industrial museum at Jackson Park. Estimated cost $5,000,000. Graham, Anderson, Probst & White, 80 East Jackson Blvd., are architects.

Ill., Chicago—Syndicate, c/o W. Bernhard & Co., 820 Tower Court, Archts., awarded contract for masonry, etc. for a 18 story hotel at 14 West Elm St. Estimated cost $1,500,000.

Ill., Lawrenceville—English Pond Drainage Dist., G. W. Lackey, Atty., is having preliminary plans prepared for the construction of a pumping plant, etc. Estimated cost $85,000. G. C. Harvey, Mount Carmel, Ill., is engineer.

Ind., Bloomington — Bd. of Trustees, Indiana University, plans to expend $150,000 for the construction of a new heating plant. C. R. Ammerman, Continental Bank Bldg., Indianapolis, is engineer.

Ind., Walkerton — Bd. of Trustees will soon award contract for waterworks improvements including new well, remodeling pumping station, one vertical triplex pump, one gasoline engine, etc. Estimated cost, $25,000.

Ia., Rochester—Iowa Ry. & Light Corp., 201 Second Ave., Cedar Rapids, Ia., is having preliminary plans prepared for the construction of a hydro-electric development on the Cedar River near here to include 26 x 140 ft. power plant, dam, five generating units, etc. Estimated cost $2,000,000.

La., Monroe—City will readvertise for bids soon for waterworks improvements including pumping station, earthern dam on Bayou De Siard river, motor driven centrifugal pumps, switchboard, etc. Estimated cost $150,000. Burns & McDonnell Engineering Co., Interstate Bldg., Kansas City, Mo., is engineer. Former bids rejected.

Mass., Boston—Hospital Dept. awarded contract for addition to boiler house at City Hospital, Albany St., to M. S. Kelleher Co., 21 North Munroe St., Dorchester. Estimated cost $152,956.

Mass., Danvers — Commonwealth of Massachusetts, South Essex Sewage Bd., Fort Ave., Salem, awarded contract for the construction of a pumping station, etc., at foot of Doty Ave., here, to T. F. McCarthy, 342 Broadway, Revere.

Mass., Dorchester (Boston P. O.)—Boston Ice Co., 110 State St., Boston, is having plans prepared for the construction of an ice plant at Dewar and Auckland Sts., here.

Mass., Nolyoke—Holyoke Water Power Co., R. E. Barnett, Pres., 1 Canal St., has been granted permit to construct a hydro-electric power plant in connection with the dam the company now maintains on the Connecticut River. Plans provide for a power plant having four hydro-electric units, aggregate capacity 40,000 hp.

Mass., Wellesley (Boston P. O.)—Water Dept., will soon award contract for the construction of a waterworks pumping station. Estimated cost $25,000.

Mich., Detroit—Bd. of Water Comrs., 176 East Jefferson Ave., will receive bids until Apr. 11 for the superstructure of a 22 story office building including steam heating system, boilers, elevators, etc. on Bates St. Estimated cost $1,600,000. L. Kamper Inc., Cass Ave., is architect.

Mo., St. Louis—Bd. of Public Service, J. Pritchard, Dir., 208 City Hall, will soon receive bids for the construction of two high pressure steam heating lines and returns complete from municipal service building boiler room to city hall, $60,000.

Mo., St. Louis—Local Syndicate, c/o Pleitch & Price, Arcade Bldg., Archts., will soon receive bids for a 15 story apartment building including steam heating system, etc. at 3745 Lindell St.

Mo., St. Louis—Syndicate, c/o R. E. Tisdale, 3617 South Grand Blvd., Archt., will soon receive bids for an 8 story apartment building including vapor steam heating and electric refrigeration systems, electric elevators, etc., at Grand and Russell Blvds.

Mo., University City—Bd. of Education, 6701 Delmar Blvd., is having preliminary plans prepared for the construction of a high school including steam heating system, etc., at Jackson Dr. and Dorsett and Shaftsbury Sts. Estimated cost $1,000,000. Trueblood & Graf, 1517 Chemical Bldg., St. Louis, and Ferrand & Fitch, 6188 Delmar Blvd., University City, are associate architects.

N. H., Westboro—Boston & Maine R.R., Boston, Mass., awarded contract for the construction of a boiler house here, to Rowe Construction Co., Main St., Woodsville, N. H. Estimated cost $50,000.

New Jersey—Public Service Electric & Gas Co., 80 Park Pl., Newark, is having plans prepared for three high tension switching stations, 132,000 v. capacity each at Metuchen, Roseland and West Orange. Estimated cost $40,000 each. Public Service Production Co., 80 Park Pl., Newark, is engineer.

N. J., Newark—Owner, c/o F. Grad, 1023 Broad St., is having plans prepared for a 20 story hotel including steam heating and ventilation systems, boilers, elevators, etc. at Broad and Camp Sts. Estimated cost $1,000,000.

N. Y., Brooklyn — Bureau of Yards & Docks, Navy Dept., Washington, D. C., awarded contract for the construction of a refrigeration plant here to M. Barash, 60 Bergen St., Brooklyn, N. Y.

N. Y., Brooklyn—Clark Henry Corp., c/o Bing & Bing, 119 West 40th St., New York, plans the construction of a hotel at 101 Hicks St., here. Estimated cost $2,000,000. E. Roth, 1440 Broadway, New York, is architect. Work will be done by separate contracts.

N. Y., Flushing—Quinlan Terry Johnson, 93 Main St., is having sketches made for the construction of an office building and bus terminal at Amity and Main Sts. Estimated cost $1,500,000. W. W. Knowles, Bank of Manhattan Bldg., Long Island City, is architect.

N. Y., New York—Bryant Improvement Co., J. Levy, Pres., 152 West 42nd St., had plans prepared for a 16 story loft and factory building at 304 East 45th St. Estimated cost $1,000,000. Buchman & Kahn, 2 Park Ave., are architects.

N. Y., New York—Canabbe Holding Corp., M. Cantor, Pres., 50 Broad St., awarded contract for a 31 story hotel at 142-162 West 31st St., to Thompson-Starrett Co., 250 Park Ave. Estimated cost $4,500,000.

N. Y., New York — Dwellers Building Corp., B. Brodsky, Pres., 69 5th Ave., had plans prepared for two 6 story apartment buildings, one at Park East Adee Ave. and one at Arnow, Wilgus and Barker Aves. Estimated cost $1,000,000 each. Private plans. Work will be done by separate contracts.

N. Y., New York—Ellbar Realty Corp., W. Baker, Pres., 16 East 52nd St., had plans prepared for a 15 story apartment building at 973 Park Ave. Estimated cost $1,000,000. J. M. Felson, 250 West 57th St., is architect.

N. Y., New York—J. E. Gilbert, 501 7th Ave., plans the construction of a 14 story apartment building at 79th and 80th Sts. and East End Ave. Estimated cost $1,000,000. Architect not selected. Owner is general contractor.

N. Y., New York — Superintendent of Standards and Purchase, Capitol, Albany, will receive bids until Apr. 19 for refrigeration work for New York House of Refuge at Randall's Island here.

N. Y., Patchogue—Village, J. P. Kosee, Clk., Sewer Dist. No. 1, will receive bids until Apr. 17 for extensions and improvements to sewers and pumping stations in East Main St. and in South Ocean Ave. H. Burdett, Cleveland, 225 Broadway, New York, N. Y., is consulting engineer.

N. Y., Poughkeepsie — Dept. of Mental Hygiene, Capitol, Albany, will receive bids until Apr. 25 for refrigeration work, etc., for power plant at Hudson River State Hospital here.

N. C., Charlotte — Oasis Temple Shrine had plans prepared for a 30 story shrine mosque, hotel and office building on South Tryon St. Estimated cost $2,250,000. M. L. Hampton and R. J. Jordan, Statesville, are architects.

N. C., Charlotte—Duke Power Co., 511 5th Ave., New York, N. Y., plans the construction of first unit of steam power plant at Riverbend on Catawba River near here to include two 75,000 hp. steam turbo generators, etc. Estimated cost of complete plant of three units $12,000,000. Work will be done by owners' forces.

N. C., Lenoir—City awarded contract for the construction of a water filtration plant and pumping station to Moser & Bumgarner, Hickory. Estimated cost $62,737.

O., Cleveland—National Town & Country Club Co., G. A. Schneider, c/o Wade Park Manor, plans the construction of a 10 story club house at East 24th and Euclid Ave. Estimated cost $2,000,000. W. S. Ferguson Co., 1900 Euclid Bldg., is architect and engineer.

O., Dayton—Dayton Hotel Co., C. Sprigg, Pres., Horries Bldg., awarded contract for a 16 story hotel at First and Main Sts. to Starrett Co., 160 North La Salle St., Chicago, Ill. Estimated cost $3,000,000.

Ore., Portland — Loyd Corp. is having plans prepared for a 10 story hotel including steam heating system, boilers, electric elevators, etc., at 13th, 14th, Holliday and Mullnowah Sts. Estimated cost $3,000,000. J. L. DeLavier, 535 West Knoll Dr., West Hollywood, Calif., is architect and engineer.

Tex., Cleburne—Gulf, Colorado & Santa Fe Ry. Co., Galveston, is having plans prepared for the construction of a power house here. Estimated cost including equipment $125,000. F. Merritt, Ch. Engr.

Tex., Merkel — H. M. Coleman, Mineral Wells, and C. A. Watts, Merkel, plans the construction of a 25 ton ice plant here. Estimated cost $35,000. Private plans. Work will probably be done by day labor.

Tex., Midland—Magnolia Petroleum Co., is having plans prepared for the construction of two booster stations between Midland and Sweetwater on the Midland-DeLeon pipe line. Estimated cost $100,000. Private plans.

Tex., Texarkana—Texarkana Water Corp. is having preliminary plans prepared for the construction of a waterworks system including pumping station, dam and storage reservoir on Clear Creek to impound 1,000,000 gal. of water daily. Estimated cost $350,000. Private plans.

Wis., Madison—Wisconsin Power & Light Co., 16 North Carroll St., is having plans prepared for a 10 story office building, etc. including steam heating system, elevators, etc. Estimated cost $550,000. Law, Law & Potter, 1 South Pinckney St., are architects.

Ont., Windsor—Deauville Beach Club, Book Tower, awarded contract for a 10 story club house on Lake St. Clair to Christman Burke Co., 315 Stevens Bldg. Estimated cost $1,500,000. Steam heating system, boilers, elevators, swimming pool, etc. will be installed.

Ont., Toronto—Standard Brick Co., Ltd., is having plans prepared for the construction of a boiler room, engine house, etc., at 554 Greenwood Ave.

Equipment Wanted

Electrical Equipment—Bd. of Local Improvements, Chicago, Ill., will receive bids until Apr. 12 for electrical equipment for Single Leaf Trunnion Bascule Bridge over North Branch of the Chicago River (Section B) North Robey Street Improvement.

Generator, Ash Handling Equipment, Etc.—City of Henderson, Ky., M. Y. Fieldhouse, Gen. Mgr., is receiving bids for a 2,000 kw. turbo-generator, ash handling equipment and superheat installation.

Pump and Motor—City of Maud, Okla., is in the market for a 50 g.p.m. deep well pump and motor for waterworks.

Pump and Motor—J. W. Pieratt, Clk, Apache, Okla., will receive bids until Apr. 20 for a deep well pump and motor, etc. for proposed waterworks improvements. Estimated cost $17,000.

Pump and Motor—J. W. Smith, Recorder, Osseo, Wis., will receive bids until Apr. 18 for furnishing and installing one 60 to 80 g.p.m. pump with 5 hp. motor, etc. for proposed waterworks improvements.

Pumping Equipment—Water Comrs., New Britain, Conn., will receive bids until May 15 for pumping equipment, etc. for proposed waterworks. Estimated cost $1,000,000.

Pumping Units—Bd. of Public Works, Nashville, Tenn., will receive bids until Apr. 24 for furnishing and installing two high lift and two low lift pumping units in Nashville Pumping station.

Pumps, Etc.—City of Lemoore, Calif., plans to purchase a sludge pump, water pump with motor, etc. for proposed sewage disposal plant.

Pumps, Motors, etc.—City of Charleston, S. C., J. H. Renken, Purch. Agt., will receive bids until Apr. 24 for two 2,000 g.p.m. vertical electrically driven centrifugal sewage pumps and two 1,800 g.p.m. vertical electrically driven centrifugal sewage pumps with electric motors, automatic starting apparatus, etc.

Pumps, Switchboard, Etc.—City of Monroe, La., will readvertise for bids for motor driven centrifugal pumps, switchboard, etc. for proposed waterworks improvements.

Pumps and Electrical Apparatus—City of Signal Hill, Calif., plans to purchase two pumps and electrical apparatus for waterworks.

Refrigerators, Compressors, Condensers, Etc.—Bureau of Yards & Docks, Navy Dept., Washington, D. C., plans to purchase automatic refrigerators consisting of motor driven compressors, condensers, etc. for Navy Yard (Hospital) Mare Island, Calif.

Industrial Projects

Calif., Sacramento—CAN MANUFACTURING PLANT—Continental Can Co., 155 Montgomery St., San Francisco, is having preliminary plans prepared for the construction of a can manufacturing plant here. Estimated cost to exceed $100,000.

Conn., Oakville — HARDWARE FACTORY—Smith Seymour & Son Inc., awarded contract for a 2 story, 50 x 150 ft. factory to L. A. Miller Co., 231 South Colony St., Meriden. Estimated cost $75,000.

Ill., Chicago—ROLLER FACTORY—Rapid Roller Co., 812 West Austin Ave., manufacturers of printers' rollers, awarded contract for a 3 story, 100 x 125 ft. factory at 2548 South Federal St. to G. L. Arquette, 180 North Michigan Ave. Estimated cost $250,000.

Ill., Girard—SHOE FACTORY—Magnolia Shoe Co., c/o Manske & Bartling, 410 North Euclid Ave., St. Louis, Mo., awarded contract for a 2 story, 100 x 320 ft. shoe factory to Smirl & Gibson, Girard, Ill.

Ill., Mattoon—SHOE FACTORY—Brown Shoe Co., 1600 Washington Ave., St. Louis, Mo., awarded contract for a 3 story, 40 x 200 and 45 x 75 ft. factory here to W. C. F. Kuhne, Rantoul, Ill. Estimated cost $250,000.

Mass., Charlestown (Boston P. O.)—GYPSUM FACTORY—U. S. Gypsum Co., S. L. Avery, Pres., 300 West Adams St., Chicago, Ill., plans the construction of a factory near Mystic Docks, here. Estimated cost $1,500,000.

Mich., Ann Arbor—GASOLINE GAGE FACTORY—King Seeley Co., awarded contract for a 5 story, 60 x 85 ft. factory on Second St. to Townsend Dailey Co., 214 West Michigan Ave., Ypsilanto. Estimated cost $85,000.

Mich., Battle Creek—SIGN FACTORY—Consolidated Sign Co., 99 West Main St., awarded contract for a 2 story, 50 x 250 ft. factory on Elm St. to A. L. Addel, 38 South Madison St. Estimated cost $75,000.

Mich., Detroit—ALUMINUM PRODUCTS FACTORY—Bohn Aluminum & Bronze Co., Isobel St., had plans prepared for a 1 story, 50 x 316 ft. addition to factory. C. W. Brandt, 1016 Francis Palms Bldg., is architect.

Mich., Kalamazoo—PAPER PLANT ADDITION—Kalamazoo Vegetable Parchment Co., is having plans prepared for a 2 or 3 story, 190 x 285 ft. addition to paper plant. Estimated cost $1,000,000. Billingham & Cobb, 402 Pythian Bldg., are architects. Power supplied from detached power plant.

Mich., Kalamazoo—ESSENTIAL OILS FACTORY—A. N. Todd Co., Rose Ave., awarded contract for a 3 story factory for the manufacture of mint and essential oils to O. F. Miller Construction Co., Pratt Bldg. Estimated cost $45,000.

Mich., Saginaw — MALLEABLE IRON PRODUCTS FACTORY—Saginaw Malleable Iron Works, had plans prepared for a 1 story, 80 x 90 and 80 x 110 ft. factory and foundry on Florence Ave. The Austin Co., General Motors Bldg., is engineer.

N. J., Audubon—WIRE CLOTH FACTORY—Audubon Wire Cloth Co., R. Korb, Pres., awarded contract for a 2 story, 54 x 98 ft. factory to J. D. Lawrence, Westville.

N. J., Newark—TUBE FACTORY—Hygenic Tube Co., H. Lermer, Pres., 88 McWhorten St., awarded contract for two 1 story, 52 x 125 and 13 x 40 ft. factory buildings at Ave. L. and Mary St. to A. Axel, 114 Grumman Ave. Estimated cost $40,000.

N. Y., Binghamton—VALVE FACTORY—Fairbanks Valve Co., Binghamton, or Fairbanks Co., 393 Lafayette St., New York, plans the construction of a 2 story factory to replace fire loss. Estimated cost $100,000.

Tex., Dallas — ASSEMBLY PLANT — John E. Mitchell & Co., 600 South Sixth St., St. Louis, Mo., awarded contract for a 2 story, 100 x 300 ft. assembly plant for cotton cleaning machinery to L. Morris, c/o J. A. Pitzinger, Southwestern Life Bldg., Archt. Estimated cost $100,000.

Tex., Pratt—TANNERY—San Antonio Boot Co., c/o S. L. Gill, 5500 South Presa St., San Antonio, awarded contract for first unit of tannery and leather products plant, 1 story, 80 x 175 ft. near here to Walsh & Burney, 928 North Flores St., San Antonio. Estimated cost $100,000.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

PRICE changes are few compared with March levels, in contrast with the numerous declines in evidence at this time last month. Rivets are up 15c. per 100 lb. at Pittsburgh mill. Highest grade babbitt metal advanced 2c. per lb. during the month. Packing prices tend downward with the exception of rubber sheet, which rose 5c. per lb. at New York warehouses. Wiping cloths are off 2c. per lb. on imported material.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket		(net) 68c. per ft.
Common, 2½-in., cotton, rubber-lined	80c. per ft. list, less	50%

Air—Best grade

¾-in., per ft.	3-ply $0.36½	4 ply $0.44	

Steam—Discounts from List

First grade	30-10%	Second grade	40%	Third grade	45%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade	45%	Second grade	50%

LEATHER BELTING—List price, 24c., per lin.ft. per inch of width, for single ply, at New York warehouses:

Grade	Discount from list
Medium	35%
Heavy	30%

RAWHIDE LACING { For cut, best grade, 30-10%; 2nd grade, 50-10%. For laces in sides, best, 46c. per sq.ft.; 2nd, 42c. Semi-tanned, cut, 30-10%.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ¼ in.	$0.90
Asbestos for high-pressure steam, ¼ in.	1.75
Duck and rubber for piston packing	.90
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.85
Wire insertion asbestos sheet	1.20
Rubber sheet	.55
Rubber sheet, wire insertion	.75
Rubber sheet, duck insertion	.55
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
Asbestos, air cell, for low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.25@2.35 per bbl. without bags, delivered by truck to site of job. Bag charge, 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, beams and channels, 3 to 15-in.; angles, 3 to 6-in., ¼-in. thick; tees, 3-in. and larger; and plates, ¼-in. thick and heavier; all $3.34 per 100 lb.

COTTON WASTE—The following prices are in cents per lb., at warehouse:

	New York	Cleveland	Chicago
White	10.00@13.50	16.00	15.00
Colored	9.00@13.00	12.00	12.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed, white wipers, as follows:

Chicago	$0.15
New York	.15½@.17½
Cleveland *per thousand*	38.00

LINSEED OIL—These prices are per 7½-lb. gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$0.76½	$0.84	$0.78

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry	In Oil
Red	$13.75	$15.25
White	13.75	13.75

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Tank rivets, small, including ⅞-in. dia., list (Apr. 1, 1927) less 50-10% in full packages, for immediate delivery from warehouse stocks in New York and vicinity.

Structural rivets, ½-in., per 100 lb.:
New York $5.00* Chicago $3.60† Pittsburgh mill $2.90

Cone-head boiler rivets, ½-in., per 100 lb.:
New York $5.00* Chicago $3.60† Pittsburgh mill $3.20@3.30

*Price is for full packages; broken package lots, $6.50 net, delivered. †f. o. b.

REFRACTORIES—Prices in car-loads, f.o.b. plant:

Chrome brick, eastern shipping points	per net ton	$45.00
Chrome cement, 40@50% Cr_2O_3, in bulk	per net ton	22@25
Chrome cement, 40@50% Cr_2O_3, in sacks	per net ton	26@29
Magnesite brick, 9-in. straights	per net ton	65.00
Magnesite brick, 9-in. arches, wedges and keys	per net ton	71.50
Magnesite brick, soaps and splits	per net ton	91.00
Silica brick, Mt. Union, Pa	per M	43.00
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	43@46
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 2nd quality, 9 in. shapes, Pennsylvania	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	35@38
Clay brick, 2nd quality, 9 in. shapes, Maryland	per M	35@38
Chrome ore crude, 40@50%	per net ton	18.00@22.50

BABBITT METAL—Delivered, New York, cents per lb.:

Genuine, highest grade	71.00
Commercial genuine, intermediate grade	57.00
Anti-friction metal, general service	31.50
No. 4 babbitt (f.o.b.)	12.00

COLD DRAWN STEEL—Shafting and screw stock, warehouse prices per 100 lb., base, are as follows:

	New York	Cleveland	Chicago
Round or hexagon	$3.40	$3.65	$3.60
Flat or square	3.90	4.15	4.10

BOILER FITTINGS—F. o. b. New York or Jersey City, discounts from list:

	Current
Copper ferrules	70%
Boiler flanges	65-5%
Boiler stay bolts	60%
Boiler patch bolts	20%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following discounts are to jobbers for carloads at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	13

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are net prices per 100 ft. at New York warehouses on tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17.07
1¼	.....	.....	19.20
1½	.....	$38.00	17.92
1¾	.....	28.50	20.48
2	$17.33	25.00	20.24
2¼	19.84	28.25	23.00
2½	21.60	34.00	26.03
3	25.50	42.50	27.04
3¼	30.25	49.50	30.67
3½	31.50	52.75	33.33
4	38.03	67.00	40.11

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.

These prices are net, per 100 ft., based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.

In addition to the above, standard cutting charges are as follows:

2 in. and smaller.. 5c. per cut. 3 in..... 9c. per cut.
2¼ and 2½ in..... 6c. per cut. 3½ to 4 in.... 10c. per cut.

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent. 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid.....	$29.00 (net)	$44.00 (net)	$180.00	$220.00
No. 12 solid.....	136.00	180.00	225.00	275.00
No. 10 solid.....	185.00	235.00	275.00	325.00
No. 8 stranded...	305.00	375.00	420.00	500.00
No. 6 stranded...	440.00	530.00	615.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	50%	30%
Coils to 1,000 ft.	60%	35%
1,000 to 5,000 ft.	65%	38%
5,000 ft. and over	67%	40%

CONDUIT—Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, per 100 pieces, extra f.o.b. New York warehouse. Discount of 5 per cent. for payment in 10 days. Delivery charges, approximately 4 per cent. additional.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$56.50	$61.34	$7.76	$8.83	$4.52	$4.92
⅜	72.07	78.63	10.21	11.63	6.46	7.03
1	103.31	113.00	15.10	17.21	8.39	9.13
1¼	139.77	152.88	20.51	23.07	11.78	12.75
1½	167.12	182.79	27.34	30.76	14.56	15.75
2	224.85	245.94	50.13	56.40	19.41	21.01
2½	355.50	388.85	82.03	92.28	27.73	30.01
3	464.88	508.50	218.74	246.10	41.59	45.01
3½	585.30	637.74	483.04	543.46	55.46	60.02
4	714.17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices, each, in standard-package quantities:

CUT-OUTS, PLUG, SOLID, NEUTRAL OR 2-FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID, NEUTRAL OR 2-FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$17.20
No. 16 cotton reinforced heavy		21.00
No. 18 cotton reinforced light		13.20
No. 16 cotton reinforced light		17.60
No. 18 cotton Canvasite cord		14.60
No. 16 cotton Canvasite cord		16.90
No. 16 super service cord or similar (2 wire) in 1,000 ft.	$72.00	*80.00
No. 14 super service cord or similar (2 wire) in 1,000 ft.	110.00	*122.00

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30-amp.,	100	$0.15	3-amp. to 30-amp.,	100	$0.30
35-amp. to 60-amp.,	100	.30	35-amp. to 60-amp.,	100	.60
61-amp. to 100-amp.,	50	.90	65-amp. to 100-amp.,	50	1.50
101-amp. to 200-amp.,	25	2.00	110-amp. to 200-amp.,	25	2.50
201-amp. to 400-amp.,	25	3.60	225-amp. to 400-amp.,	25	5.50
401-amp. to 600-amp.,	10	5.50	450-amp. to 600-amp.,	10	8.00

Discount: Less than one-fifth standard package, 60%; one-fifth to standard package, 64%; standard package, 70%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30-amp	$0.03 ea.	$0.05	100	100
35 to 60-amp.	.05 ea.	.06	100	100
65 to 100-amp.	.10 ea.	.10	50	50
110 to 200-amp.	.15 ea.	.15	25	50
225 to 400-amp.	.30 ea.	.30	25	25
450 to 600-amp.	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than standard package	22%
Standard package	40%
Discount Without Contract—Renewals:	
Less than standard package	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less than standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500)	$2.50
0-30 ampere, less than standard package	2.80

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard, A type bulbs:

100—130 Volt General Watts	Type	Price Each	200—260 Volt Special Watts	Type	Price Each
15	A 17	$0.23	25	A 19	$0.28
25	A 19	.23	50	A 21	.28
40	A 21	.23	100	A 23	.50
50	A 21	.25	....	....	....
60	A 21	.25	....	....	....
100	A 23	.40	....	....	....

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net, allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain, separable, attachment plug	$0.18
Composition, 2-piece, attachment plug	.27
Swivel attachment plug	.12
Small size, 2-piece plug, composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Solid Duplex
14	$5.75	$9.10	$10.69	$17.00
12	9.20	12.20	13.80	23.25
10	12.85	15.80	17.90	30.15
8	18.75	21.65	23.20	41.40
6	.....	.....	33.00	.....
4	.....	.....	46.30	.....
2	.....	.....	64.00	.....
1	.....	.....	89.35	.....
0	.....	.....	110.00	.....
00	.....	.....	129.00	.....
000	.....	.....	157.00	.....
0000	.....	.....	185.00	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In. or Pendant Cap Key	½ In. or Pendant Cap Keyless	½ In. or Pendant Cap Pull	¾ In. Cap Key	¾ In. Cap Keyless	¾ In. Cap Pull
Standard package.	$0.11	$0.11	$0.18	$0.16½	$0.15	$0.22
Unbroken carton..	.14	.13	.20	.18	.16	.23
Broken carton....	.16	.15	.22	.20	.18	.25

WIRING SUPPLIES—

Friction tape, ¾ in., less than 100 lb., 31c. per lb.	100 lb. lots....	29c. per lb.
Rubber tape, ¾ in., less than 100 lb., 33c. per lb..	100 lb. lots....	31c. per lb.
Wire solder, less than 100 lb., 33c. per lb.	100 lb. lots....	31c. per lb.
Soldering paste, 2 oz. cans		$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25.00 to $50.00 list value	30-5%
$50.00 list value or over	35%